CALIFORNIA
OIL WORLD
and Petroleum Age

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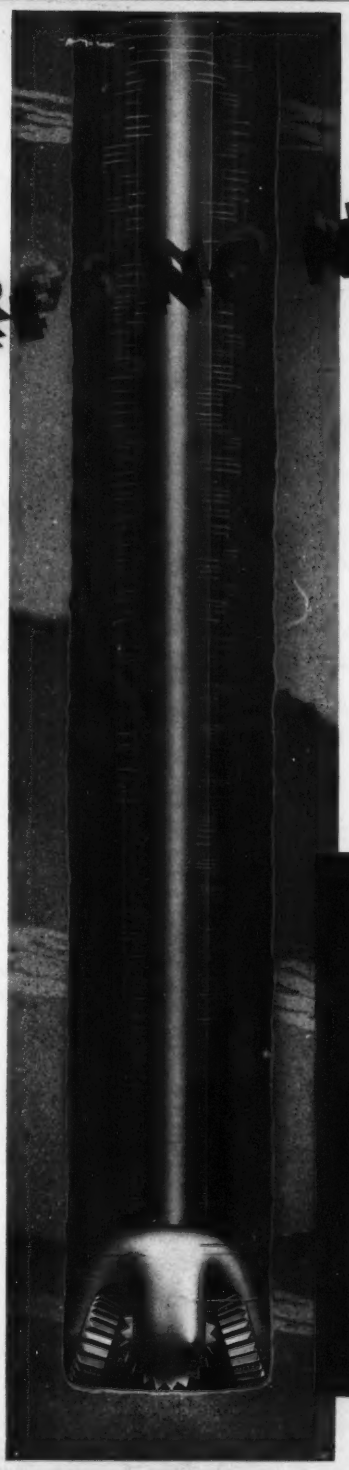
ELIMINATE VIBRATION WITH A
SIEVERS REAMER!

Vibration is the enemy of your drill string—Constant flexing weakens pipe and connections . . . shortens equipment life . . . and leads to twist-offs and expensive fishing jobs.

What's more, vibration cuts drilling efficiency—for a dancing bit can't drill as straight, or as fast, as a bit centered firmly in the hole.



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SMOOTHER, FASTER DRILLING—The exclusive Sievers Slicing Action aids—instead of hinders—the digging speed of the bit.

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BETTER DIRECTIONAL DRILLING—The diagonal wall contact gives better bearing area for holding the bit to a pre-determined course.

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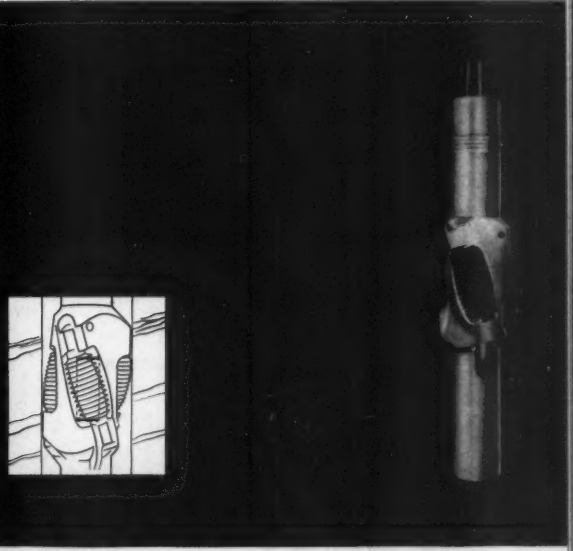

A full description of the Sievers Reamer is in your Composite Catalog & Drilling Equipment Directory.

WHETHER IT'S REAMING OR STABILIZING—OR BOTH—YOU'LL DO IT BETTER WITH A SIEVERS!

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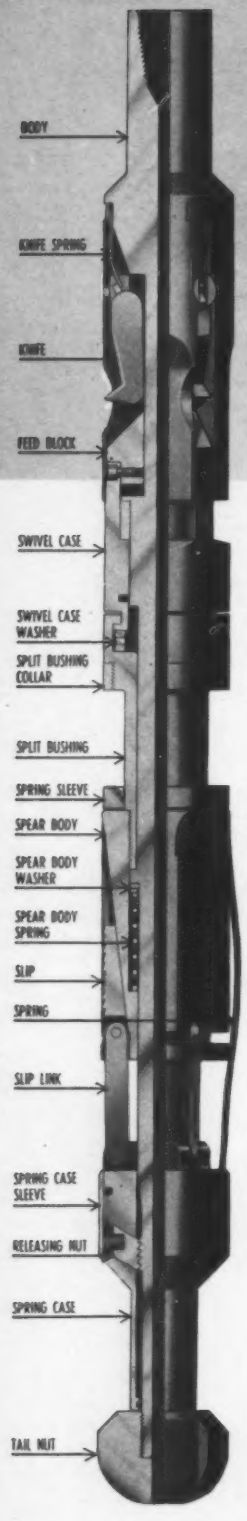
Sievers Reamers ★ Sequoia ★ Security Drill Collars

Vol. 33
No 22
Whole
No. 1573

CUT AND PULL JOBS ARE *Easier and Safer* with the BOWEN CASING CUTTER



● If the job calls for cutting casing, drill pipe or tubing, you'll do it **better** and **cheaper** with the Bowen Internal Cutter. Extremely simple and safe to operate, it makes cut after cut quickly and easily . . . without chattering or crawling. It's the ideal tool for all cut-and-pull jobs and puts a new standard of safety and efficiency on pipe cutting operations.

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No extra operations are required and no time is wasted when making cuts with the Bowen Internal Cutter. You simply run it inside the pipe . . . rotate slowly to expand the slips . . . lower to force the cutting knives out on the feed blocks . . . and rotate ahead until free action indicates that the cut is complete. After that, you can pull up to put the tool back in position for additional cuts **without coming out of the hole!** It's as fool-proof as that!

The Internal Cutter is another Bowen Fishing Tool available day or night from any of six Bowen Service Stores located in active California fields. Efficient Bowen Service Men are on the job to assist in operating the Cutter, saving valuable time and money. For cutting tubing, strings of "macaroni" are available in both Northern and Southern California. **Next time—call Bowen!**

LOOK AT THESE OUTSTANDING FEATURES ON THE BOWEN CASING CUTTER

RUGGED CONSTRUCTION

Deep or shallow, big pipe or small, the Cutter will safely stand the toughest strains. Once the slips are set, it stays on the spot while the cut is made, yet releases **instantly.**

POSITIVE ACTION

Cutting action is completely controlled by the operator—the knives are forced out or retracted simply by lowering or raising the run-in string.

SMOOTH CUTS

Three knives, evenly spaced on the body, are designed to give smooth, even cuts, free of ragged edges and burrs which might impair easy pipe removal.

MULTIPLE CUTTING

Positive setting and releasing action enables the operator to raise or lower the Cutter for several separate cuts **without coming out of the hole for adjustment.**

SR BOWEN CO

VALLEY FISHING TOOL COMPANY

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BRANCHES AT HUNTINGTON BEACH ★ LONG BEACH ★ VENTURA ★ BAKERSFIELD ★ AVENAL ★ SANTA MARIA

CALIFORNIA
OIL WORLD
and Petroleum Industry

THE AUTHORITY ON THE CALIFORNIA OIL INDUSTRY

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November 25, 1940

Telephone Number Richmond 2136

Here's THE MOST

There's a BAROID PRODUCT for every step in drilling

AQUAGEL—Concentrated colloidal gel-forming clay. One ton makes as many as 100 to 120 barrels of excellent drilling fluid when mixed with fresh water.

BAROCO—High-grade drilling clay. Makes about 40 barrels of drilling mud per ton when mixed with salt or fresh water. Particularly when used between badly contaminated salt and limestone or gypsum formations.

AQUAGEL-CEMENT—A gel-type cement which may be formed by adding a small amount of AQUAGEL to any good Portland cement in either wet or dry state. Provides better formation sheath by making a better bond between the casing and the hole.

RECOMMENDED AMOUNTS OF AQUAGEL TO BE USED IN CEMENT

Gals. Water per Sack Cement	4	4½	5	5½	6	6½	7	7½	8
Lbs. AQUAGEL per Sack Cement if first mixed with water	1	1.3	1.6	2.0	2.3	2.6	2.9	3.3	3.6	3.9
Lbs. AQUAGEL per Sack Cement if added dry with cement	2	2½	3	3½	4	4½	5	5½	6	6½

AQUAGEL—Even though no definite formation troubles are encountered, a sufficient amount of AQUAGEL should be worked in the mud to keep the water loss low and the mud cake thin. High water loss between sloughing and thick mud cake often causes stuck pipe.

AQUAGEL—2 to 3% added to drilling mud, or 6 to 10% added to straight water when pumped, or as thick slurry, has tendency to plug formations. If this fails try FIBROTEX.

FIBROTEX—Tough fibrous material for preventing or retarding lost circulation in highly porous formations. Treat 20-barrel batches of mud with from 12 to 14 pounds per barrel. One to three batches often stops serious losses of circulation. If this is unsuccessful, use AQUAGEL-CEMENT.

AQUAGEL-CEMENT—To restore circulation in extremely fractured or cavernous formations use from 7 to 10 gals. water per sack of cement with from 2 to 6½ lbs. AQUAGEL per sack. Use schedule under AQUAGEL-CEMENT in CEMENTING CASING. Slurries of approved high viscosity pump easily but do not flow away due to their gelling characteristics.

BAROCO—Salt resisting drilling clay. Maintains viscosity in the presence of salt. Makes about 40 barrels of mud per ton when mixed with salt water.

ZEOGEL—A concentrated colloidal clay which forms a gel with salt water. Yields upwards of 100 barrels of mud per ton in brine. Can be used where existing but not salt water is available.

BAROID or COLOX—Drilling mud weighting materials. Made suitably weighted with BAROID or COLOX to counterbalance pressure of salt water flows. Can be added to water mud or mixed straight with water and AQUAGEL.

AQUAGEL—Enough should be added to the mud to produce superior wall-building qualities and keep the cake thin. This will reduce greatly the tendency of formations to cave.

BAROID or COLOX—Suitably weighted muds have demonstrated their efficiency in holding caving or blowing formations in place.

STABILITE—There are several formulas of STABILITE, both liquid and dry, the choice of which depends upon the condition of mud contaminating materials in the mud or the time treatment is required. Reduces viscosity and gel-strength and improves wall-building qualities.

STABILITE—Reduces danger of blowouts by freeing entrained gas, thereby keeping mud weight constant.

BAROID or COLOX—Highly weighted muds are frequently necessary to confine gas or other pressures.

AQUAGEL—Sufficient should be worked in all muds to keep the water loss low and the cake thin.

SIMENTOX—When drilling ahead after a cement job, the use of SIMENTOX counteracts the effects of cement on mud. A small amount added to mud after a cement job will often eliminate the necessity of drilling the mud. Viscosity is reduced and wall-building qualities restored.

AQUAGEL—In Low-Pressure Areas—Straight AQUAGEL water mud (5½% to 7% by weight depending upon the caking water mud is the ideal mud for drilling in. The low water loss keeps water from the sand and the thin cake is quickly and easily removed. Wells drilled in with this field mud as production and clean up quicker.

BAROID or COLOX—In High-Pressure Areas—A combination of BAROID or COLOX and AQUAGEL muds up to suitable weight is the ideal drilling fluid. In locations where the natural mud provides adequate wall-building qualities BAROID or COLOX added to the mud in sufficient quantities will provide adequate weight to insure safety.

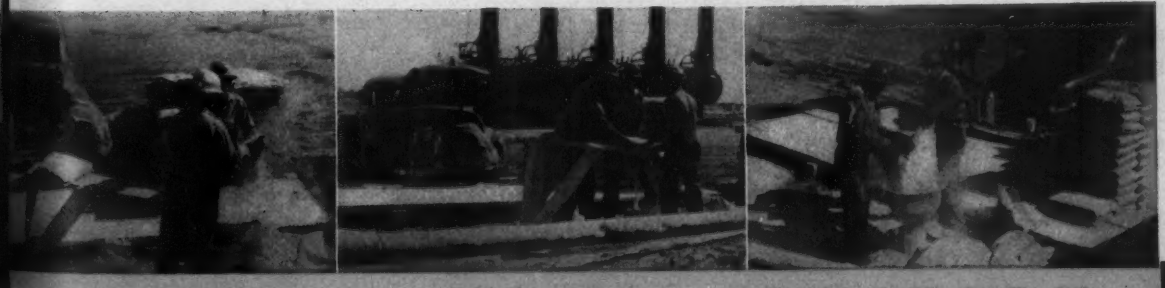
STABILITE—If gas cutting of the mud occurs, add suitable quantities of STABILITE in either liquid or powdered form.

BAROID
OIL WELL DRILLING MUD SERVICE

IMPORTANT PAGE *from the* BOOK OF DRILLING EXPERIENCE

Operators who use Baroid Products regularly in all their wells, find that this is an economical procedure because it eliminates many drilling difficulties and speeds up drilling operations. In addition to this, the measure of safety provided by the use of Baroid Products many times proves of inestimable value.

Baroid Products meet all drilling conditions in deep or shallow wells. Use them for *faster, safer, more economical* drilling!



BAROID SALES DIVISION
National Lead Company

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BAROID
OIL WELL DRILLING MUD SERVICE

Baroid Products and Serv
Engineers are available in
active oil fields of the U. S

BAROID SALES OFFICES: LOS ANGELES TULSA HOUSTON

San Francisco is 1941 A.P.I. Meeting City

Chicago Papers Feature Defense Role

The 22nd Annual Meeting of the American Petroleum Institute will be held in San Francisco November 3-7, 1941, the board of directors of the Institute voted at the annual meeting just closed in Chicago. Tulsa was selected for the Mid-Year meeting.

A. S. Russell, vice president of Standard Oil Co. of California, was elected to fill the unexpired term of the late President William H. Berg as director. Among other changes in the directorate, Ralph B. Lloyd, of Lloyd Corp., was elected to succeed Neal Anderson, of Pilot Oil Co., both Californians.

Preparations and present status of the petroleum industry for national defense were the main topics at the first general session of the American Petroleum Institute's 21st annual meeting in Chicago, Nov. 13.

Virtually no bottlenecks of any kind are evident in an examination of the capacities of the petroleum industry, two speakers asserted, one of them declaring that it is in "the best position of any basic industry" to serve the nation in defense.

Need More 100 Octane Plants

The only places where immediate expansion of effort was urged were in the building of additional refining capacity for 100-octane super aviation fuel, increasing transportation facilities, particularly tanker capacity, and the erecting of some additional storage capacity and providing for the safeguarding from sabotage and possible attack of present storage points. The industry should have ample time to complete its 100-octane fuel plants, was stated, because present production and capacity are more than adequate for current needs and even a sizeable increase in demand, and the greatly-increased demand probably will not come for 18 months.

Dr. Robert E. Wilson, president of Pan-American Petroleum and Transport Co., New York, and head of the petroleum section, raw materials division of the Advisory Commission to the Council of National Defense, and Colonel T. H. Barton, president of Lion Oil Refining Co., El Dorado, Arkansas, described the present state of preparedness of the industry for the oil men assembled from all parts of the nation. Both urged the rapid development of unity, and better understanding and cooperation in the nation, between industry and government.

Industry Upsurge Seen

Dr. Wilson said that the petroleum industry understandably has not yet felt the upward surge of orders based on national defense preparations, because heavy industry must first produce the equipment to use the fuels and lubricants. He estimated, however, that a substantial increase would be felt by next spring. This might be sufficient even in its early stages he said, to offset the current losses in export business, and thereafter will increase steadily to a figure beyond any requirements the industry has yet seen.

Production Branch Ready

Capacity of each branch of the industry was analyzed by Dr. Wilson, who found that at only two or three points is immediate expansion necessary to get ready for the increased demand that will come next year. In the producing branch, he stated, the industry particularly is well prepared. Under prorated conservation regulations in most of the leading oil states the wells currently are producing at only a fraction of their potential capacity, and could be opened up at a moment's notice to fill any conceivable increase.

Today's shut-down refineries alone have a capacity that is greater and more efficient than the entire refining capacity of the industry in 1917, he reported. Only for the production of 100-octane aviation fuel will immediate construction of additional plant facility be advisable, although present capacity probably is great enough to handle our needs for this fuel for 18 months.

Dr. Wilson urged, however, that all existing plants for the production of both 100-octane and 91-octane fuel be operated at capacity and none diverted to ordinary motor fuel, so that a large stock reserve may be built up. Other branches of the industry are in good shape, he reported, except that some additional tanker capacity will have to be provided.

Rubber and TNT

Besides the good state of preparedness in its own affairs, the oil industry probably will be called upon to help eliminate bottlenecks in other industries by supplying large quantities of cheap hydrocarbons needed as raw materials. The two most prominently mentioned have been synthetic rubber and TNT, both of which readily can be made from petroleum.

Gas Reform Plant at Pittsburg, Calif.

Colonel T. H. Barton, president of Lion Oil Refining Co., El Dorado, Ark., reported that not only is the industry adequately prepared for vitally-important military and industrial needs, but it will meet civilian needs as well. He cited figures comparing the present facilities and capacities of the industry with those with which it successfully oiled and fueled the Allies in the first World War and asserted that the oil industry better than any other industry meets the 12 stated principles set up by the National Defense Advisory Commission for the awarding of defense contracts.

The number of producing oil wells in the United States nearly has doubled since 1917, he said, and wells today are drilled five times as fast as ten years ago. Crude oil reserves have reached the highest point in the history of the industry and are three times greater than in 1917. Refining capacity is four times larger.

Laboratories and their scientific control of oil-well drilling are moving directly into the oil fields, J. T. Hayward, of Barnsdall Research Corp., told a Drilling and Production Practice session of the Division of Production.

Application of modern instrument techniques of the continuous drilling of oil wells, with equipment for recording and analysis operated at the well, promises to make possible the more successful completion of many wells, Mr. Hayward said, and to give fewer opportunities for passing by potential oil-producing zones during drilling.

Continuous Well Logging

Through the use of newly-perfected instruments, Mr. Hayward discovered, minute traces of the character of the underground formations penetrated by the drill can be detected in the drill cuttings

carried to the surface in the drilling mud which circulates down through the drill pipe and back to the surface. Modern drilling techniques also have perfected numerous other instruments which automatically determine the conditions of drilling.

When all of these records are taken at one time, while the well is being drilled and immediately correlated, a continuous drilling log that does not interrupt drilling and which provides most of the basic data needed for both immediate and future study, can be made for the first time. This virtually was an impossibility in the past because the more usual methods of finding out what is happening as the drill progresses—coring, drill-stem testing, and electrical logging—all require an interruption in drilling operations, and because much of the equipment has not been available at the well.

Mr. Hayward described in detail the equipment used to effectuate this important innovation in oil-well logging techniques. Mounted in a trailer, all the instruments and laboratory equipment necessary to make complete records and analyses can be moved readily from well to well, and provide the first practical method of on-the-spot control of drilling, with the facts known at once. The trailer also brings other laboratory control directly to the field of operations, including equipment for analysis of drilling cores, and for testing the composition of drilling mud, an important factor in successful drilling.

Mud Circulating Systems

Another speaker at this session, which was devoted to various problems in drilling and production practice, was W. W. Moore of Tulsa, who described the hydraulics of mud-circulating systems.

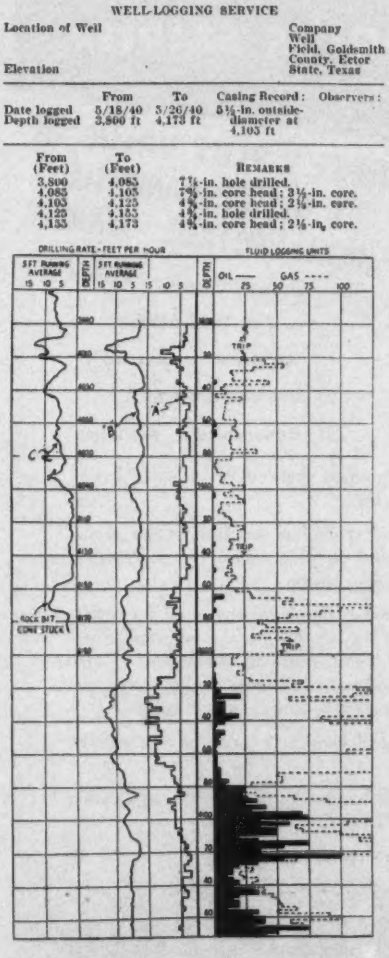
Mr. Moore's paper did not cover the control or conditioning of drilling muds, but was concerned primarily with a discussion of the physical problems involved in the circulation of the mud. Drilling muds, which have a number of specific functions including the removal of drill cuttings from the face of the bit, the sealing of the well wall, the maintenance of pressure sufficient to hold back any extreme gas pressures developed, and a number of others, are forced under pump pressure down through the drilling pipe, through the bit, and back up in the hole outside the drill pipe.

More economical drilling operations can be conducted when the actual hydraulics of this circulation are understood, Mr. Moore declared. In many wells, he said, the overall mechanical efficiency of the mud circulating system can be improved materially and drilling costs lowered by a consideration of these factors.

Instruments and laboratory techniques gradually are being perfected, it was reported, that soon will make it possible for oil men to know almost as much about how oil, gas, and water really behave in the oil reservoir itself as though they could see it happening before their eyes two to three miles below the earth's surface.

Two petroleum engineers told the session in detail how far the industry has come in the last 10 years in an appreciation of the importance of having exact factual knowledge of conditions in the oil sand itself. They discussed the factors that affect the sand's performance, the methods that can and should be used in determining the magnitude of these factors, and their significance in planning an operating program for each oil field.

R. D. Wyckoff and M. Muskat, both of Gulf Research and Development Co., in two papers, reviewed and correlated the known data bearing on this fundamental problem of the oil industry. Rapid adoption and application of this growing knowledge has been of major importance in increasing the ultimate recovery of many oil fields, and undoubtedly has conserved large quantities of oil in the nation's reserve.



WELL-LOGGING SERVICE

Location of Well — Company Well Field, Goldsmith County, Ector State, Texas

Elevation

	From	To	Casing Record:	Observers:
Date logged	5/15/40	5/26/40	5½-in. outside-diameter at 4,103 ft	
Depth logged	3,800 ft	4,173 ft		

From (Feet)	To (Feet)	Remarks
3,800	4,085	7⅞-in. hole drilled.
4,085	4,105	5⅝-in. core head; 2½-in. core.
4,105	4,125	4⅝-in. core head; 2¼-in. core.
4,125	4,155	4⅝-in. hole drilled.
4,155	4,173	4¾-in. core head; 2⅛-in. core.

DRILLING RATE - FEET PER HOUR — FLUID LOGGING UNITS

5FT. RUNNING AVERAGE — DEPTH — OIL — GAS

Typical log from the mud laboratory on wheels.

Caltech Study

Some phases of the fundamental research into the basic behavior patterns of the thousands of hydrocarbons which combine to make up crude petroleum, and which ultimately affect its recovery from the ground, were discussed by W. N. Lacey, of California Institute of Technology, Pasadena, Calif. The discussion, touching on multiple liquid phases in hydrocarbon solutions and particularly the separation of asphaltic material during production processes, was a partial interim report on the progress of the Petroleum Institute's Research Project No. 37, of which Dr. Lacey is director. Although this fundamental research into the phase behavior of hydrocarbons is of immense magnitude because of the literally thousands of different hydrocarbons involved and inter-related in petroleum, it is probable that eventually the knowledge gained will have tremendous significance in determining the scientific planning of oil production.

In the two papers on reservoir performance factors, Mr. Wyckoff described and catalogued the factors from a broad and more theoretical viewpoint, while Mr. Muskat correlated and gave the methods for determining the magnitude of the factors on individual fields. Mr. Wyckoff told how the oil engineer's emphasis in the past decade quite naturally "shifted from the function of wells to control of production, then to conservation, and finally focused on the reservoir and its performance." He classified the various factors affecting reservoir performance, and described in general terms the equipment and methods for determining them.

Mr. Muskat told in detail the exact engineering data which should be obtained during the drilling and development of oil fields, and described their application to the problems of estimating petroleum reserves, completing wells, controlling production performance, and finally in deciding on secondary recovery operations.

Perfumes, dyestuffs, fruit essences, anti-freeze, artificial silk, synthetic rubbers and plastics, paints, lacquers, explosives, solvents, and inks are only a few of the scores of industrial chemicals and synthetic raw materials now being manufactured from petroleum and natural gas on a commercial scale, a petroleum chemist reported.

Other speakers told the petroleum technologists about the use of a farm product, lecithin made from soy beans, as an additive to gasoline which helps to prevent sunlight discoloration and stor-

age corrosion, laboratory method of exact separation of petroleum hydrocarbons which may be important in large-scale refining operations, naphtha polyform and gas reversion refining processes which have been extremely successful in the economical manufacture of high-quality motor fuels, and a new rapid and low-cost method of separating oil from crystalline waxes.

L. Rosenstein, of Shell Chemical Co., described the progress made in the last 10 years in the manufacture of synthetic chemicals and reported that "it is becoming a major American industry. Petroleum is well suited as a chemical raw material; it is cheap and abundant, and contains a wide variety of chemical types which may be converted to derivatives of many kinds. "Chemical manufacture," he said, "unquestionably will play an increasingly important role in the oil industry. The exact future is not certain but in some instances there actually may be a reversal of the original position, and the petroleum refinery may be utilizing the by-products of the chemical factory."

Besides the scores of industrial chemicals and synthetic raw materials already being manufactured from petroleum on a commercial scale, Mr. Rosenstein said, dozens of other products have been shown to be feasible whenever a demand is created. The revolution in gasoline manufacture which has resulted in the commercial production of the important super aviation fuels got its first impetus, he stated, in early chemical synthesis from petroleum. During one of the steps in the synthesis of secondary-butyl-alcohol, an industrial chemical, the source of aviation's new super fuel, isooctane, was uncovered.

Lecithin, one of the phosphatides which recently has been produced at low cost from soy beans, is an effective deterrent to the deterioration of gasoline on exposure to sunlight, a paper by H. V. Rees, W. S. Quimby, and J. C. D. Oosterhout, of The Texas Co., reported. Addition of lecithin also has an important corollary effect, they stated, in decreasing corrosion of storage-tanks and galvanized drums, particuarly where the product stored is a highly-leaded aviation gasoline. Corrosion in aluminum aviation-gasoline tanks also is reduced.

Exact separation of the hydrocarbon fractions of petroleum is becoming increasingly important in chemical synthesis, three scientists of the National Bureau of Standards stated, and a new laboratory method of distillation which makes this exact separation possible for the first time for certain of the hydrocarbons may become commercially desirable for refinery processes. Frederick D. Rossini, Beveridge J. Mair, and Augustus Glasgow, Jr., reported that when a mixture of two hydrocarbons with the same boiling point is to be separated, it often can be accomplished by the addition of a third substance which will alter the boiling points of both original substances, and enable them to be separated easily by distillation. The process is called azeotropic distillation. This paper describes part of the work being done under Research Project 6 of the Institute's board of directors, of which Dr. Rossini is director, and Messrs. Mair and Glasgow are research associates.

J. E. Bogk, of Phillips Petroleum Co., P. Ostergaard, of Gulf Oil Corp., and E. R. Smoley, of The Lummus Co., cooperated in the presentation of a paper on "The Naphtha Polyform and Gas Reversion Processes," which make possible increased yields of high-quality motor fuel.

A. H. Schutte, of The Lummus Co., described a newly-developed refining process, "The Emulsion De-oiling Process," which brings modern technique to one part of refining which has not been changed materially in many years, the separation of oil from crystalline waxes in the prepartion of semi-refined wax stocks. The new process takes minutes compared to days under the previous method and requires low plant and operating costs.

Possibility of the development of a revolutionary lightweight deisel engine to meet national defense requirements was described by H. C. Mougey, of General Motors Corp.

Mr. Mougey declared that recent research work had indicated that in a war-

50,000 KVA

OF SHORT-CIRCUIT PROTECTION

RIGHT IN THE MOTOR STARTER

HERE'S PLUS VALUE IN A G-E OIL-IMMERSED HIGH-VOLTAGE STARTER

IT ALSO PROVIDES

1. Resistance to corrosion
2. Overload protection
3. Undervoltage protection

ENOUGH capacity to interrupt a three-phase short circuit of 50,000 kva—that's what you get in this G-E starter.

It doesn't require additional fault-current protection for itself or the motor it controls. Furthermore, you can depend on it to resist the mechanical stresses that a short circuit on the line may set up.

All operating parts of this starter are completely immersed in oil for resistance to corrosive atmospheres. The highly efficient, isothermic, induction-temperature overload relay, which provides overload protection, is also immersed in oil. The magnetic time-delay undervoltage trip prevents unnecessary shutdowns and unexpected restarting after a power failure.

Two forms are available: the lift-out-of-tank type and the framework-mounted, tank-lowering type.

Our nearest Western representative will be glad to discuss the application of this control with you. Contact him TODAY.

GENERAL ELECTRIC CO., SCHENECTADY, N. Y.

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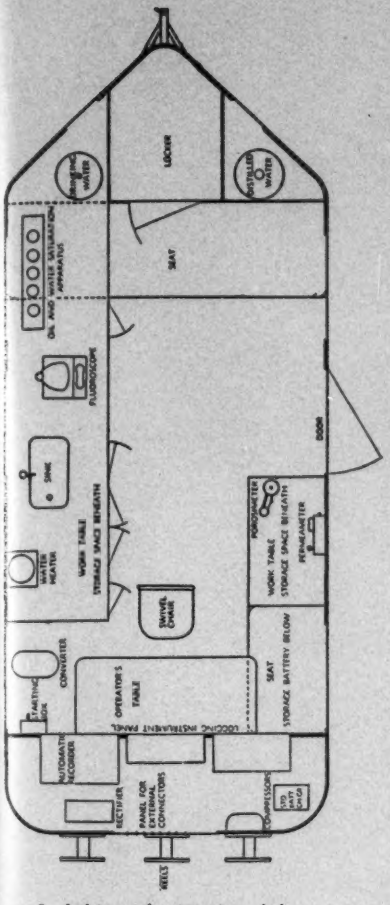


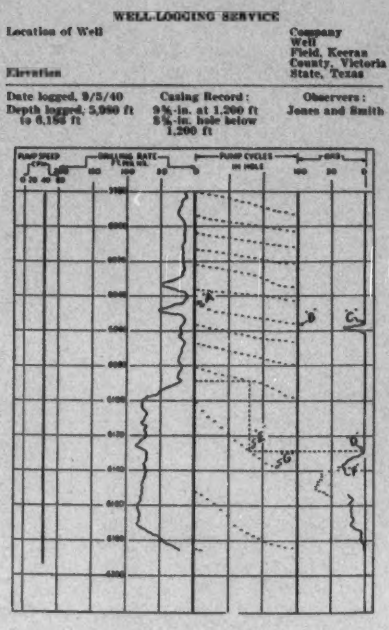
And this is the interior of the new well logging laboratory.

time emergency it would be possible to construct large power diesel engines with weights as low as 3 pounds per horsepower. This compares with present diesel weights of 10 pounds per horsepower and weights of 25 pounds per horsepower in diesel engines constructed as late as 1926. Weight economy could be achieved, he said, through special construction and the use of lightweight alloys.

The most important recent development in diesel engine operation, he said, was the inauguration this year of main-line diesel-operated freight trains. Diesels heretofore have been limited to passenger trains and yard-switching work.

Lubricating oils today must meet more severe service conditions than ever before as a result of the heavy duty they are called upon to perform, he said, and cited the example of a fleet of diesel-powered motor coaches operating between Chicago and the Pacific Coast, which operate about 20,000 miles per month for each coach.

The petroleum and automotive industries are industrial Siamese twins, he said. Not only is the original cost of an automobile approximately the same as the



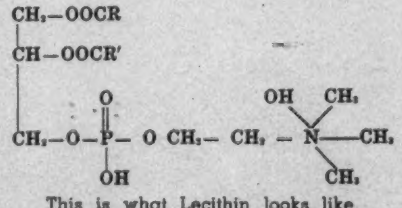
Typical Recorder Chart produced by continuous well logging plant.

cost of the petroleum products used by the vehicle during its expected life, but the progress in one industry is dependent to a large degree on progress in the other industry.

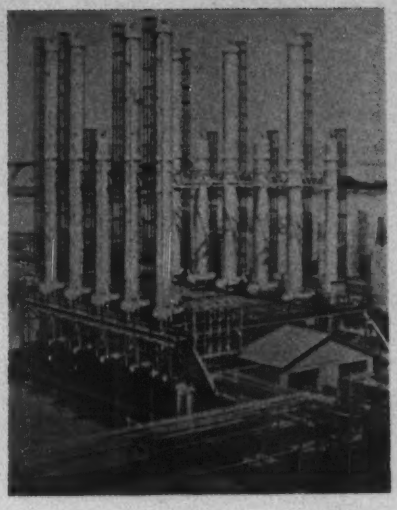
"The automobile industry has followed the petroleum industry in developing automobiles that will use improved quality to the best advantage," he said. "In this work, improvements in automobile engines have followed and not preceded the development in fuels, as obviously it is impossible for the automotive industry to market automobiles in large numbers unless the fuel to operate these automobiles is available."

Completion of one of the longest and most exhaustive controlled-test programs ever conducted by the oil industry, a 10-year testing of thousands of applications of scores of different protective coatings for pipe lines at 12 test sites throughout the country, was reported.

Soil corrosion has caused immense economic loss to the pipe-line branch of the oil industry, and the conclusions from the observations and measurements made after the buried pipes were uncovered earlier this year undoubtedly will prove highly important in the study of corrosion control.



This is what Lecithin looks like.



Petroleum Chemicals Fractionating columns.

The project, which was started in 1930 by the Institute with the cooperation of manufacturers of protective coatings and the National Bureau of Standards, cost directly more than $25,000 and represented an additional expenditure of more than $100,000 by the participants. K. H. Logan, chief of the Underground Corrosion Section, of the National Bureau of Standards, Washington, D. C., who supervised the final inspection of the test specimens, delivered the report.

Mr. Logan's conclusions, in part, were: "The data on the conductance of the coatings lack uniformity. Not infrequently one section of a coating showed many times the conductance of another section of the same coating at the same test site. The same statements are applicable to maximum pit depths. The important fact is that the amount of protection afforded by many coatings was not uniform even under nominally the same condition."

Meter Study

Measuring crude oil as well as petroleum products with meters has offered many problems to oil men and meter manufacturers, and a second paper at this session described the progress in research on oil meters which has been conducted since 1932 by the College of Engineering of the University of Oklahoma, Norman, Okla. Dean W. H. Carson of the college, and associate professor E. E. Ambrosius reported on the accuracy and durability tests being made on 10 types of meters to study the nature of errors in measurement, and the effects on measurement of associated conditions such as the uniformity of fluids, the elimination of solids, effect of meter and line pulsations, materials and design,

(Continued on Page 43)

I. E. Kemnitzer, E. W. Galliher, J. B. Anderson, E. L. DeMaris, R. E. Golemon, E. J. Bartosh.

D. H. Thorn

enneth Wright

W. D. Kleinpel and Frank Morgan

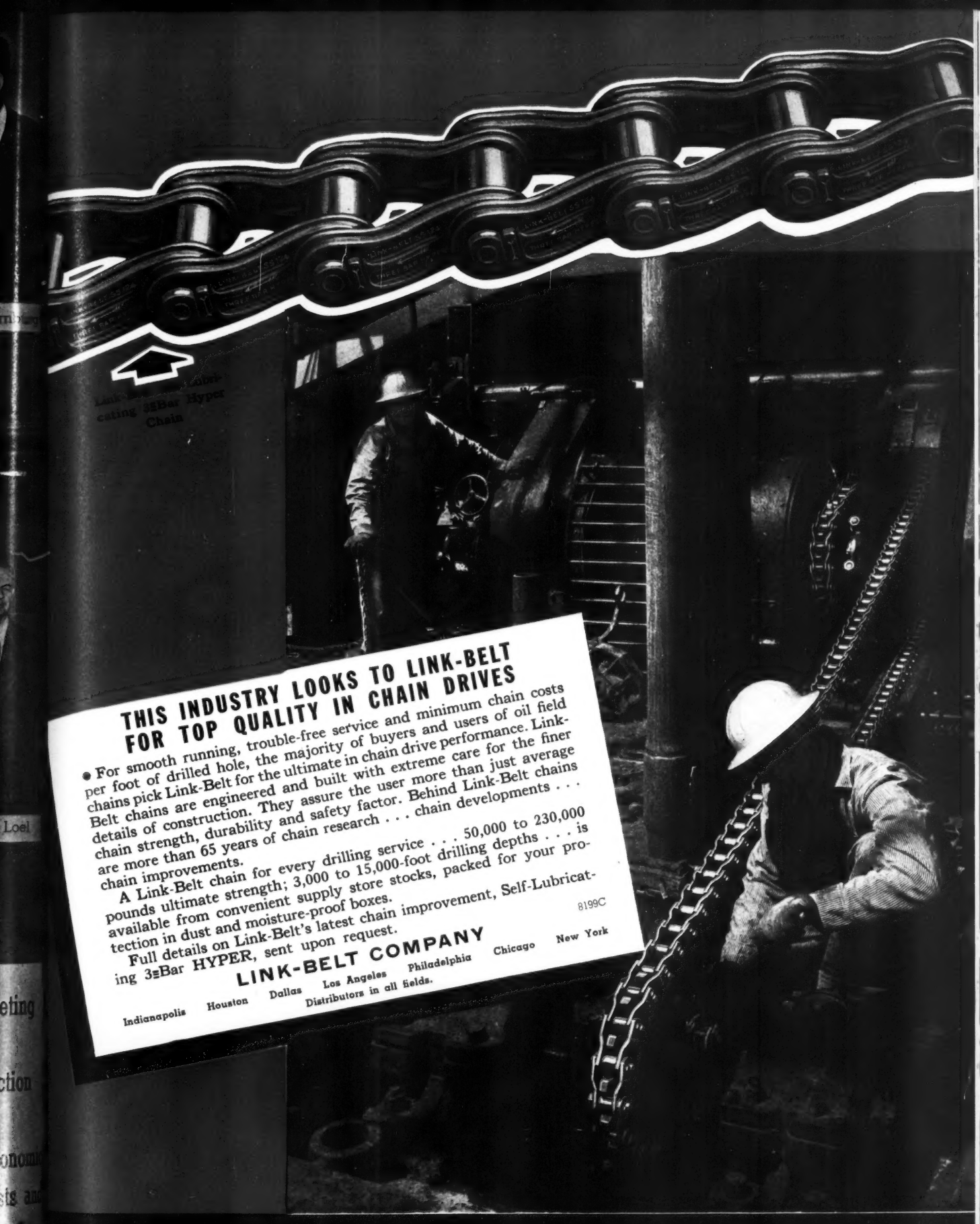
F. S. Hudson

Annual Convention
of
Pacific Section
American Association
of
Petroleum Geologists
Los Angeles
Nov. 7 and 8

Wayne Loel

C. Snider, A. F. Peterson

Annual Meeting
of
Pacific Section
of the
Society of Economic
Paleontologists and
Mineralogists
Los Angeles
Evening of Nov.



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Conversion of Light Hydrocarbons to High Anti-Knock Aviation Fuels

C.N.G.A. 1940 FALL MEETING

A Review by S. H. McAllister
Shell Development Company,
Emeryville, California

The past six years have brought about many developments in the field of petroleum refining but in no phase of the industry has there been more progress made than in the manufacture of aviation fuels. This is only logical if we consider that the advances in airplane engine design are necessarily dependent upon the availability of suitable fuels. The direction of this change has been to increase the power output per unit of engine weight and this has called for a fuel which will not "knock" under high compression and which has the other desirable properties of high B.t.u. content per pound, fluidity at low temperatures, proper volatility, stability in storage and reasonable cost.

There are a large number of hydrocarbons and oxygenated compounds which might be considered for aviation fuels in blends with or without the addition of lead and they might meet these requirements to a greater or lesser extent but the branched chain paraffins appear at present to be outstanding and it is with the commercial syntheses of these hydrocarbons that this paper is concerned

In Table 1 are given typical specifications for aviation gasoline which will illustrate the boiling range and volatility requirements. High octane number and B.t.u. content are particularly desired for military airplanes but it is only a matter of time until commercial air lines will have similar requirements and as expansion of the military requirements is inevitable the highest quality fuels are of the greatest interest

The 15th Annual Fall All-Day Meeting of the California Natural Gasoline Association, Nov. 1, in Los Angeles, was featured by the presentation of four outstanding papers. These papers and pictures of the men active in the big technical session are published in the following pages.

Up until 1934 the only pure isoparaffinic materials available in quantity were isobutane and isopentane but they were far too volatile to be used alone. Thus commercial aviation fuels were limited to selected fractions available in normal refinery operations; these seldom exceeded 80 A.S.T.M. octane number unleaded. Isooctane was available as a reference fuel but its cost prohibited its use on any but a laboratory scale. In 1934 the Shell Group embarked upon the commercial production of isooctane for use in military airplanes and from that time very rapid progress has been made. A wide number of polymerization and hydrogenation processes have been developed and recently alkylation processes have entered this field.

While a number of processes have been proposed, only a few have advanced to wide commercial acceptance. Rather than attempt to survey the entire field studied in the laboratory, it appears desirable to confine this paper to the proven practical processes. These include:

1. The Cold Acid Polymerization Process.
2. The Hot Acid Polymerization Process.
3. The U. O. P. Polymerization Process.
4. The Polyco Polymerization Process.
5. Liquid Phase Phosphoric Acid Polymerization.
6. Sulphuric Acid Alkylation.
7. Thermal Alkylation.
8. Related Processes such as Hydrogenation and Dehydrogenation.

All of these processes are now used to provide the branched chain paraffins which when blended with selected straight run gasolines of proper volatility provide the higher grades of airplane fuel.

The Houdry Catalytic Process has frequently been mentioned as a source of aviation gasoline, but it is omitted in this discussion as it is not comparable to the above processes. The Houdry product has an octane number of only 78-80, and is somewhat unsaturated and slightly sour[1], whereas the alkylation or polymerization processes to be discussed produce a fully saturated, stable and sulphur-free product of over 85 octane number. Houdry product after further treating, may, however, provide a suitable blending fuel which would reduce the requirement of isooctane, etc.

The Cold Acid Polymerization Process

The Cold Acid Process represents the

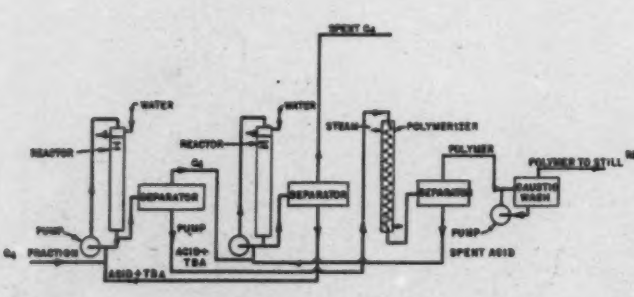

FIGURE 1
SHELL CATALYTIC POLYMERIZATION PROCESS
SOLID-ACID ISOOCTANE PLANT

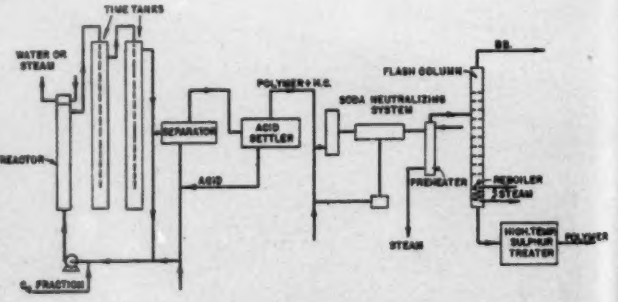

FIGURE 2
SHELL CATALYTIC POLYMERIZATION PROCESS
HOT-ACID POLYMERIZATION PLANT

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pioneering effort in the field of producing 100 octane fuels. Plants were installed by Shell Oil, Standard Oil of New Jersey, Anglo-Iranian, and a number of other companies. While many of these plants were later modified to the Hot Acid Process or replaced by other units, a description of the process is given here as a basis for comparison and to illustrate the advances which have since been made.

A flow sheet of the process is shown in Fig. 1. It is divided into two sections, an absorption section and a polymerization section. The feed consists of a refinery C_4 fraction from cracking operations which has been rendered substantially sulphur-free by repeated caustic washing. A typical feed from a California refinery has the following composition:

Isobutylene	18%
a- and b-Butylenes	30%
Isobutane	9-12%
Butane	43-40%
Sulphur	<0.0005 wt. %

The liquid hydrocarbon is contacted with 65% sulphuric acid at 20.35° C. countercurrently in two stages. Under these conditions over 90% of the isobutylene is absorbed into the acid while the normal butylenes are relatively unaffected. The absorption is an equilibrium reaction and is favored by the use of large acid-to-olefine ratios and lower temperatures. If the acid strength is increased to above 70% or the temperature raised above 35° C., slow polymerization occurs with the production of a poor grade of polymer.

The acid phase containing the absorbed butylenes is separated from the hydrocarbon layer and is passed to the polymerizers which consist of coils heated to 100°C. Polymerization is complete in about one minute and the product is then cooled and separated from the acid. The acid is returned to the absorption unit and the polymer is caustic washed and distilled to recover the diisobutylene. When 65% acid is used, 75% of the polymer is dimer and the rest trimer; the trimer is usually added to motor gasoline to improve its octane number.

The dimer fraction is hydrogenated to produce isooctane. When a C_4 feed containing less than .0005% sulphur (turbidimetric) has been used, it is possible to hydrogenate with a very active type of catalyst prepared by the reduction of nickel nitrate on porcelain or other similar carrier. This is the practice used in the Shell Group. A flow sheet of a possible plant is shown in Figure 2[2].

The hydrogenation process operates at about four atmospheres pressure and

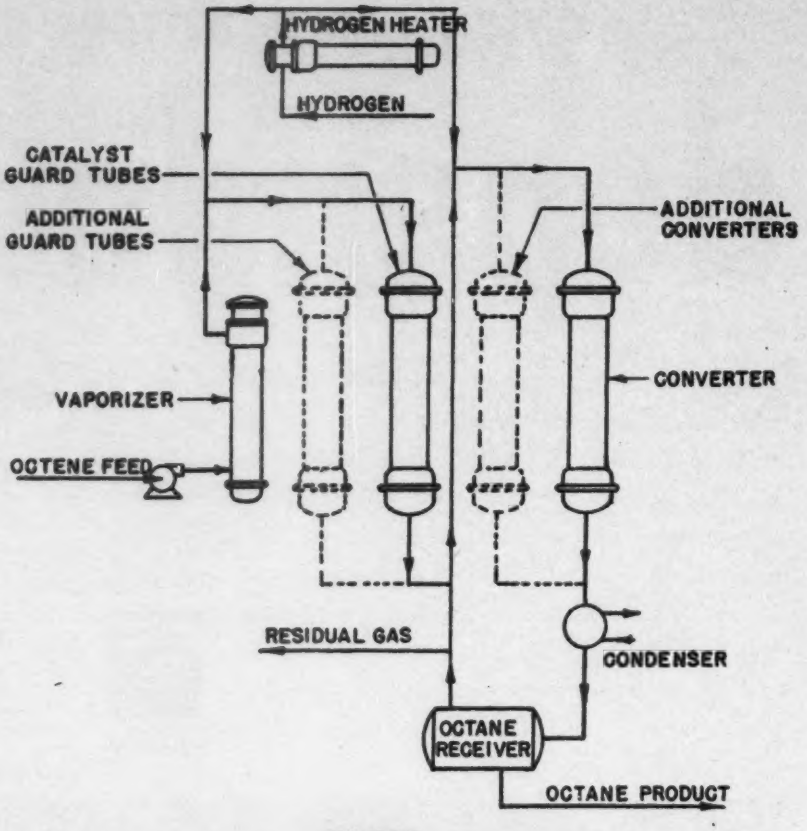

FIGURE 2

SHELL CATALYTIC HYDROGENATION PROCESS

SINGLE-STAGE SYSTEM WITH CATALYST GUARD TUBES

200°C.. The hydrogen is derived from the pyrolysis of natural gas or the dissociation of ammonia. It should be free of sulphur and carbon monoxide in order to prevent poisoning of the catalyst. A catalyst tube for converting carbon monoxide to methane and water is usually included in plants where the hydrogen is derived from pyrolysis.

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As a means of prolonging the catalyst life it is customary to manifold the reactors in such a way that the fresh feed enters the converter which has the least active catalyst. While such catalyst may not be very active for hydrogenation, it is still capable of reacting with traces of sulphur and thus it acts as a guard tube for the more reactive catalyst In this way it is perfectly possible to obtain more than 1,000 gallons of finished isooctane per pound of nickel in the catalyst chambers. The product obtained is fully saturated and by definition has a 100 octane number.

Hot Acid Operation

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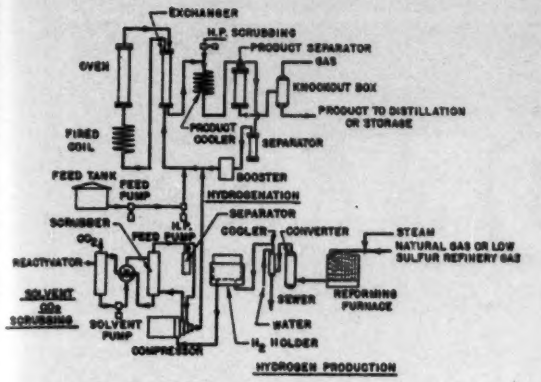

FIGURE 4
FLOW SHEET OF TYPICAL HYDROGENATION UNIT
(USING SULPHUR-RESISTANT CATALYST)

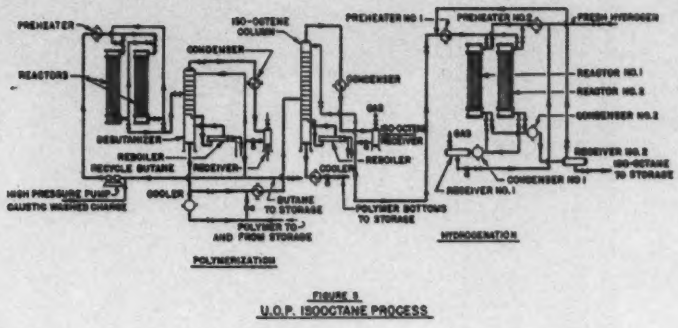

FIGURE 5
U.O.P. ISOOCTANE PROCESS

TABLE 1
SPECIFICATION OF AVIATION GASOLINES

Grade	87*	90*	95*	100
Octane No.	87	90	95	100
T.E.L., ml./gallon, max.	3	4	4	3
T.E.L., ml./gallon, min.			3.5	
Reid Vapor Pressure	7	7	7	7
Sulphur, max.	.10	.10	.10	.10
Freezing Point, max., °F.	−76	−76	−76	−76
Water Tolerance	±2	±2	±2	±2
Acid Heat, °F.	15	15	15	15
Caloric Value, B.t.u./lb.	19,000	19,000	19,000	19,000
Gum, mg.	6	6	6	6
Corrosion				
Copper strip, Copper dish	No grey or black discoloration			
Distillation, max., °F.				
10%		158		
50%		212		
90%		257		
Sum of 10% and 50%, min., °F.		307		
Distillation Recovery, min.		97		
Distillation Residue		1.5		
Distillation Loss		1.5		
Acidity of Residue		Neutral		

*—Data from A.P.I. paper of Heron and Beatty, New Orleans (May 18, 1939).

TABLE 2
COMPARATIVE EFFICIENCY, COLD-ACID AND HOT-ACID OPERATION

	Cold Acid 65 Per Cent 30-35 Deg. C.	I 65 Per Cent Acid 80 Deg. C.	II 65 Per Cent Acid 90 Deg. C.
Fuel Composition:			
Isobutylene, per cent by weight	18.5	18.5	9.1
n-Butylene, per cent by weight	28.0	28.0	20.6
Butanes, per cent by weight	53.5	53.5	70.3
Products:			
Isobutylene, per cent	2.4	0	0
n-Butylenes, per cent	26.6	15.1	11.4
Butanes, per cent	53.5	53.5	70.3
Polymer, per cent	17.5	31.4	18.3
Isobutylenes polymerised, per cent	87	100	100
n-Butylenes polymerised, per cent	5	46.0	44.5
Total olefins polymerised, per cent	37.5	67.5	61.5
Composition of Polymer:			
Sulphur (A.S.T.M.), per cent	0.01	0.03*	0.062*
Octenes, per cent	75	88	92
Octane rating of hydrogenated octenes	100	99.2	98.8

*—Negligible sulphate esters present.

the acid; thus the acid phase acts as a catalyst and the isobutylene is completely polymerized. Moreover under these conditions an approximately equal quantity of n-butylenes reacts with the isobutylene to form interpolymer. The result is that the total yield of polymer is more than double that obtained with cold acid and less trimer is formed. A comparison of the efficiency of the two processes is shown in Table 2. The increased yield of octanes is readily apparent.

A flow diagram of a commercial Hot Acid Plant is shown in Figure 3. The reaction temperature is usually between 70 and 90°C. and acid of 70% strength is used. The acid to hydrocarbon phase ratio is usually about 1/1 and the contact time expressed as volume of hydrocarbon throughput per volume of reaction space is 20-30 minutes. The former Cold Acid Plants are readily adapted to this type of operation. No external heating is required as the reaction is sufficiently exothermic to maintain the reactor temperature once the unit is on stream.

In this system the polymer is recovered from the hydrocarbon stream after caustic washing to remove entrained acid. In addition, it is necessary to remove any stable acid esters present by a high temperature hydrolysis of the polymer. In this latter treatment the total sulphur is reduced from 0.2 to less than 0.03% and the treated material is then stable to distillation. The sulphur content of the dimer cut is below .004% and is suitable for hydrogenation in the same type of unit as is used with the Cold Acid dimer.

Operation of the Hot Acid process is extremely simple and largely automatic. With proper supervision and control of reaction conditions, corrosion is not serious. The reactors in the Shell Refineries are still in use after several years and no major replacements have been made. Plants have been constructed by Humble Oil Company, Standard Oil of New Jersey, and one of somewhat different design by the Anglo-Iranian Oil Company.

An alternative method of hydrogenation is used in some plants where the sulphur in the feed is comparatively high. This method has been developed largely by the Standard Oil Company of New Jersey. A sulphur resistant molybdenum catalyst is used with pressures up to 3000 lbs. per sq. in. A flow sheet is shown in Figure 4[4]. Hydrogen is usually prepared by the action of steam on methane, although any convenient source can be used.

The quality of the hydrogenated Hot Acid dimers is exceptionally good and compares favorably with that of pure isooctane itself, both as to lead susceptibility and blending value as is shown in Tables 3, 4, and 5.

U.O.P. Polymerization

Probably the most widely used polymerization process is that developed by the Universal Oil Products Company. The catalyst is composed of phosphoric acid impregated into a carrier and it is capable of polymerizing not only butylenes but propylene and ethylene as well. The wide use of the process has led to some confusion regarding its application for the preparation of saturated aviation fuels of better than 90 octane number unleaded. It is only in the selective poly-

[4] *Refinery Catalog, Process Section, 6th Ed., 1939, page 397. Gulf Publishing Co.*

pioneering effort in the field of producing 100 octane fuels. Plants were installed by Shell Oil, Standard Oil of New Jersey, Anglo-Iranian, and a number of other companies. While many of these plants were later modified to the Hot Acid Process or replaced by other units, a description of the process is given here as a basis for comparison and to illustrate the advances which have since been made.

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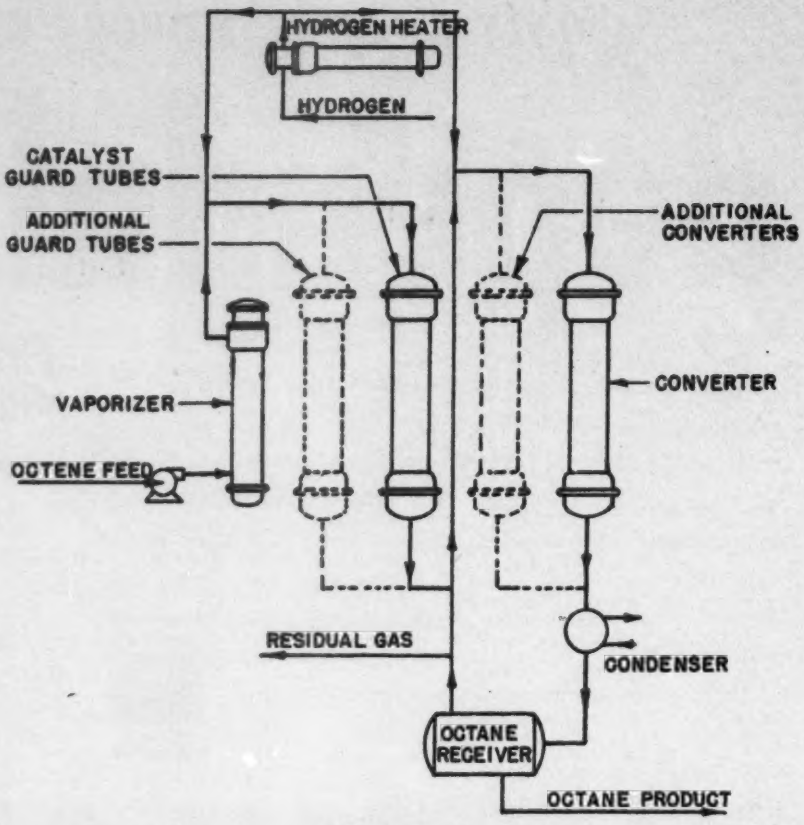

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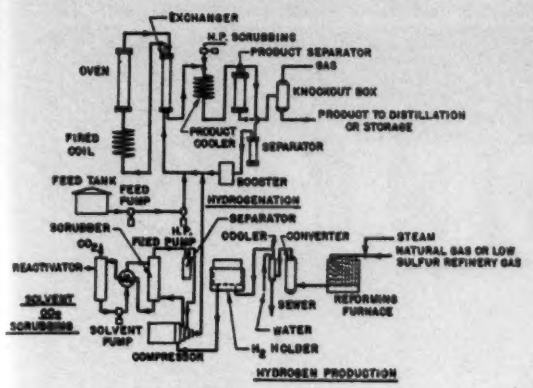

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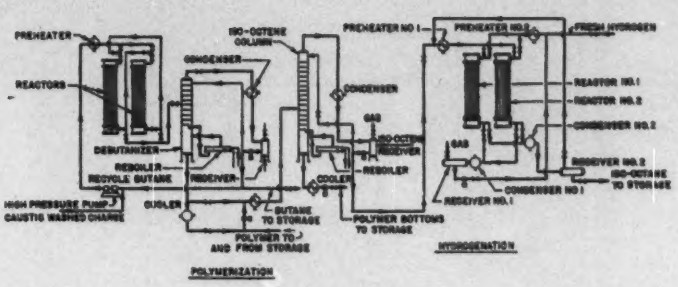
(USING SULPHUR-RESISTANT CATALYST)



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Freezing Point, max., °F.	−76	−76	−76	−76
Water Tolerance	±2	±2	±2	±2
Acid Heat, °F.	15	15	15	15
Caloric Value, B.t.u./lb.	19,000	19,000	19,000	19,000
Gum, mg.	6	6	6	6
Corrosion: Copper strip / Copper dish	No grey or black discoloration			
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10%	158			
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TABLE 2
COMPARATIVE EFFICIENCY, COLD-ACID AND HOT-ACID OPERATION

	Cold Acid 65 Per Cent 30-35 Deg. C.	I 65 Per Cent Acid 80 Deg. C.	II 65 Per Cent Acid 90 Deg. C.
Fuel Composition:			
Isobutylene, per cent by weight	18.5	18.5	9.1
n-Butylene, per cent by weight	28.0	28.0	20.6
Butanes, per cent by weight	53.5	53.5	70.3
Products:			
Isobutylene, per cent	2.4	0	0
n-Butylenes, per cent	26.6	15.1	11.4
Butanes, per cent	53.5	53.5	70.3
Polymer, per cent	17.5	31.4	18.3
Isobutylenes polymerized, per cent	87	100	100
n-Butylenes polymerized, per cent	5	46.0	44.5
Total olefins polymerized, per cent	37.5	67.5	61.5
Composition of Polymer:			
Sulphur (A.S.T.M.), per cent	0.01	0.03*	0.062*
Octenes, per cent	75	88	92
Octane rating of hydrogenated octenes	100	99.2	98.8

*—Negligible sulphate esters present.

the acid; thus the acid phase acts as a catalyst and the isobutylene is completely polymerized. Moreover under these conditions an approximately equal quantity of n-butylenes reacts with the isobutylene to form interpolymer. The result is that the total yield of polymer is more than double that obtained with cold acid and less trimer is formed. A comparison of the efficiency of the two processes is shown in Table 2. The increased yield of octanes is readily apparent.

A flow diagram of a commercial Hot Acid Plant is shown in Figure 3. The reaction temperature is usually between 70 and 90°C. and acid of 70% strength is used. The acid to hydrocarbon phase ratio is usually about 1/1 and the contact time expressed as volume of hydrocarbon throughput per volume of reaction space is 20-30 minutes. The former Cold Acid Plants are readily adapted to this type of operation. No external heating is required as the reaction is sufficiently exothermic to maintain the reactor temperature once the unit is on stream.

In this system the polymer is recovered from the hydrocarbon stream after caustic washing to remove entrained acid. In addition, it is necessary to remove any stable acid esters present by a high temperature hydrolysis of the polymer. In this latter treatment the total sulphur is reduced from 0.2 to less than 0.03% and the treated material is then stable to distillation. The sulphur content of the dimer cut is below .004% and is suitable for hydrogenation in the same type of unit as is used with the Cold Acid dimer.

Operation of the Hot Acid process is extremely simple and largely automatic. With proper supervision and control of reaction conditions, corrosion is not serious. The reactors in the Shell Refineries are still in use after several years and no major replacements have been made. Plants have been constructed by Humble Oil Company, Standard Oil of New Jersey, and one of somewhat different design by the Anglo-Iranian Oil Company.

An alternative method of hydrogenation is used in some plants where the sulphur in the feed is comparatively high. This method has been developed largely by the Standard Oil Company of New Jersey. A sulphur resistant molybdenum catalyst is used with pressures up to 3000 lbs. per sq. in. A flow sheet is shown in Figure 4[4]. Hydrogen is usually prepared by the action of steam on methane, although any convenient source can be used.

The quality of the hydrogenated Hot Acid dimers is exceptionally good and compares favorably with that of pure isooctane itself, both as to lead susceptibility and blending value as is shown in Tables 3, 4, and 5.

U.O.P. Polymerization

Probably the most widely used polymerization process is that developed by the Universal Oil Products Company. The catalyst is composed of phosphoric acid impregated into a carrier and it is capable of polymerizing not only butylenes but propylene and ethylene as well. The wide use of the process has led to some confusion regarding its application for the preparation of saturated aviation fuels of better than 90 octane number unleaded. It is only in the selective poly-

[4] *Refinery Catalog, Process Section, 6th Ed., 1939, page 397. Gulf Publishing Co.*

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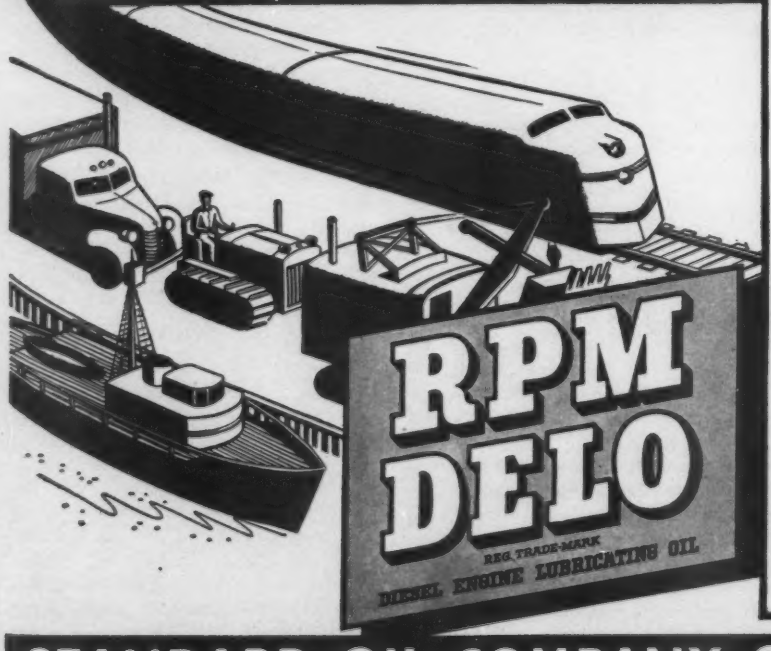

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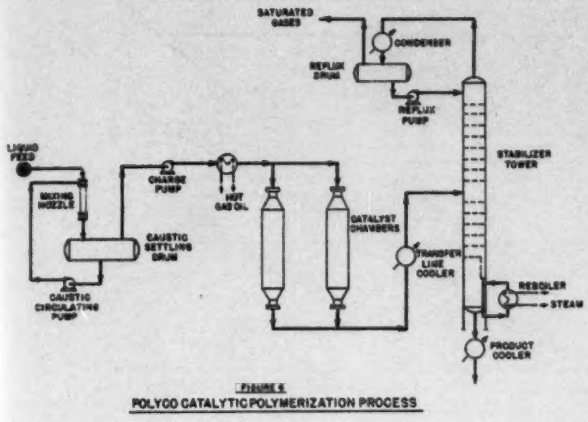
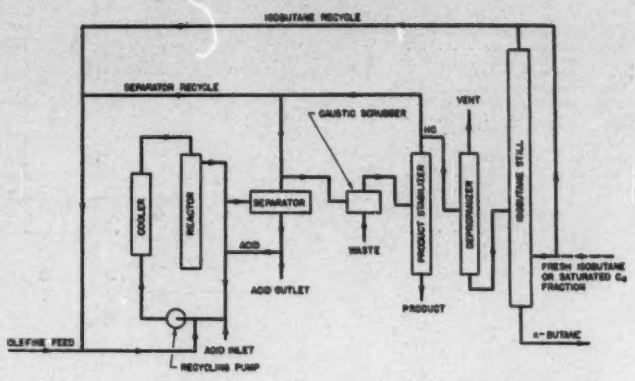
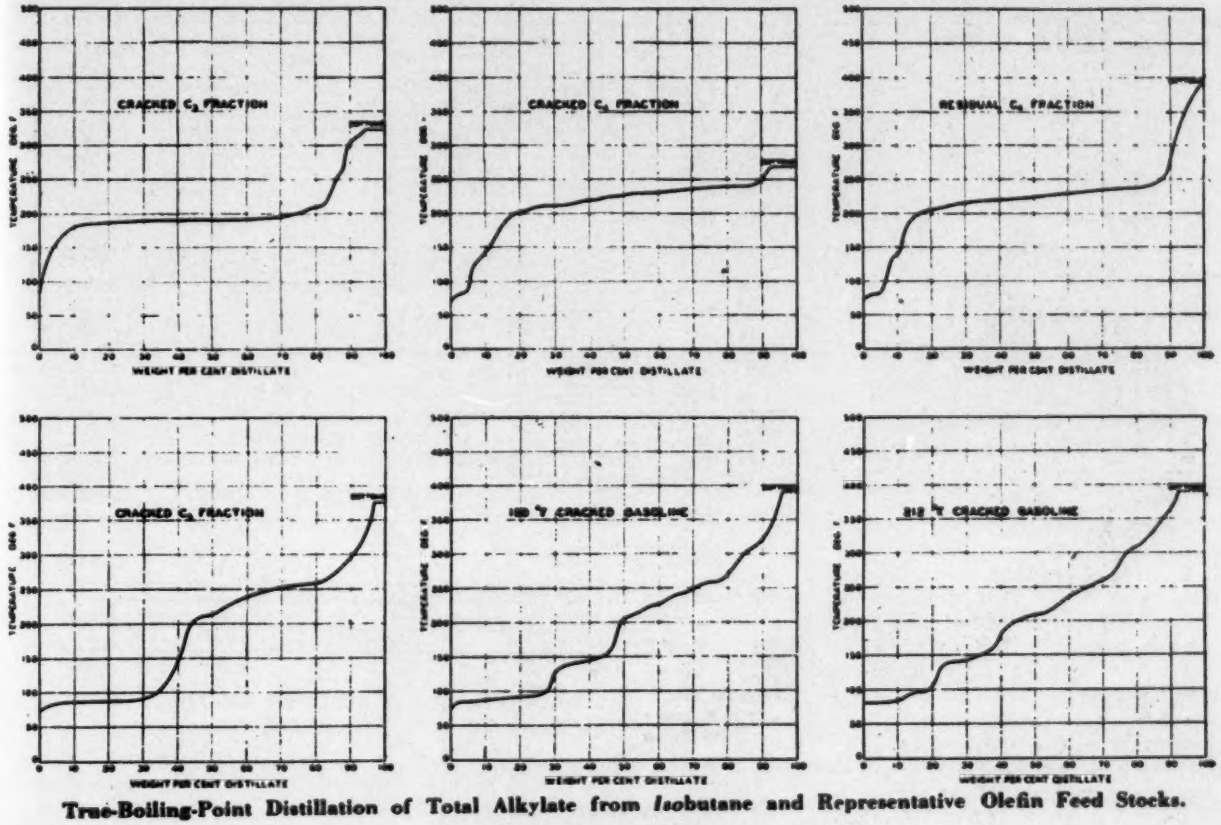


FIGURE 6
POLYCO CATALYTIC POLYMERIZATION PROCESS

FIGURE 7
SIMPLIFIED FLOW DIAGRAM FOR ALKYLATION PLANT
(TIME TANK TYPE)





True-Boiling-Point Distillation of Total Alkylate from *Isobutane* and Representative Olefin Feed Stocks.

Figure 8

merization of C_4 fraction that product comparable to Hot Acid Octanes or Isooctane is obtained. Polymerization of n-butylene alone gives a polymer of less than 90 octane number which is not improved by hydrogenation. Polymerization of propylene yields a product which on hydrogenation has an octane number less than 70 A.S.T.M. Hydrogenated product of 96 or better octane number is obtained only when approximately equal quantities of butylene and isobutylene are reacted and thus the yield is the same as obtained in Hot Acid Operation.

A flow diagram of the U.O.P. Selective Polymerization ("Isooctane Process") is shown in Figure 5[8]. Refinery cracked C_4 fraction after washing with caustic is passed through a preheater and then to the reactors. The temperature in the reactor is from 150-180° C. and the pressure, 600-800 lbs. After polymerization the hydrocarbon is distilled to remove the butanes and excess butylenes, and the polymer fractionated into a dimer and trimer cut. The dimer cut is then hydrogenated in a manner similar to that used for the Hot Acid Process.

The U.O.P. catalyst loses its activity with use due to carbon formation on the surface. It can be partially regenerated by controlled oxidation with air followed by rehydration with steam. Eventually, however, the structure is impaired and the catalyst must be completely rebuilt.

---

[8] *Ibid, page 407.*

TABLE 3
COMPARISON OF HOT-ACID OCTANE WITH TECHNICAL ISOOCTANE

	Hot-Acid Octane	Technical Isooctane
Reid vapor pressure, lb. per sq.in.	2.3	2.1
Color, Saybolt	30+	30+
A.P.I. gravity, deg.	66.5	70.9
Olefin, per cent	1.5	1.8
Copper-dish gum, mg. per 100cc.	1	1
Accelerated aging test, mg. per 100 cc.	1	1
Wright acid heat, deg. F.	24	23
Navy acid heat, deg. F.	3	3
A.S.T.M. Distillation, Deg. F.:		
Initial boiling point	208	205
Dry Point	233	235
10-per-cent point	222	210
20-per-cent point	224	210
30-per-cent point	225	210
40-per-cent point	226	211
50-per-cent point	226	212
60-per-cent point	227	212
70-per-cent point	227	212
80-per-cent point	228	214
90-per-cent point	229	215
95-per-cent point	231	216
Distilled, per cent	99	99
Sulphur, (Nephelometric), per cent	0.0001	0.0001

TABLE 4
ANTI-KNOCK BLENDING OCTANE NUMBERS

Aviation Base Stock (Per Cent)	Hot-Acid Octane (Per Cent)	Technical Isooctane (Per Cent)	Octane No.
100	...	...	74.3
75	25	...	79.1
75	...	25	79.3
50	50	...	84.8
50	...	50	85.2
25	75	...	90.9
25	...	75	91.0
0	100	...	99.1
0	...	100	99.7

Note: 100 per cent hot-acid octane and 100 per cent technical isooctane were matched against one another in an engine, and hot-acid octane is found only slightly lower.

TABLE 5
LEAD SUSCEPTIBILITY—50 PER CENT OF AVIATION BASE STOCK AND 50 PER CENT OF OCTANES

Tetraethyl Lead (CC. per Gal.)	Blend with Hot-Acid Octane	Blend with Technical Isooctane
0.0	84.8	85.2
1.0	94.6	94.6
2.0	97.0	97.1
3.0	98.7	99.1

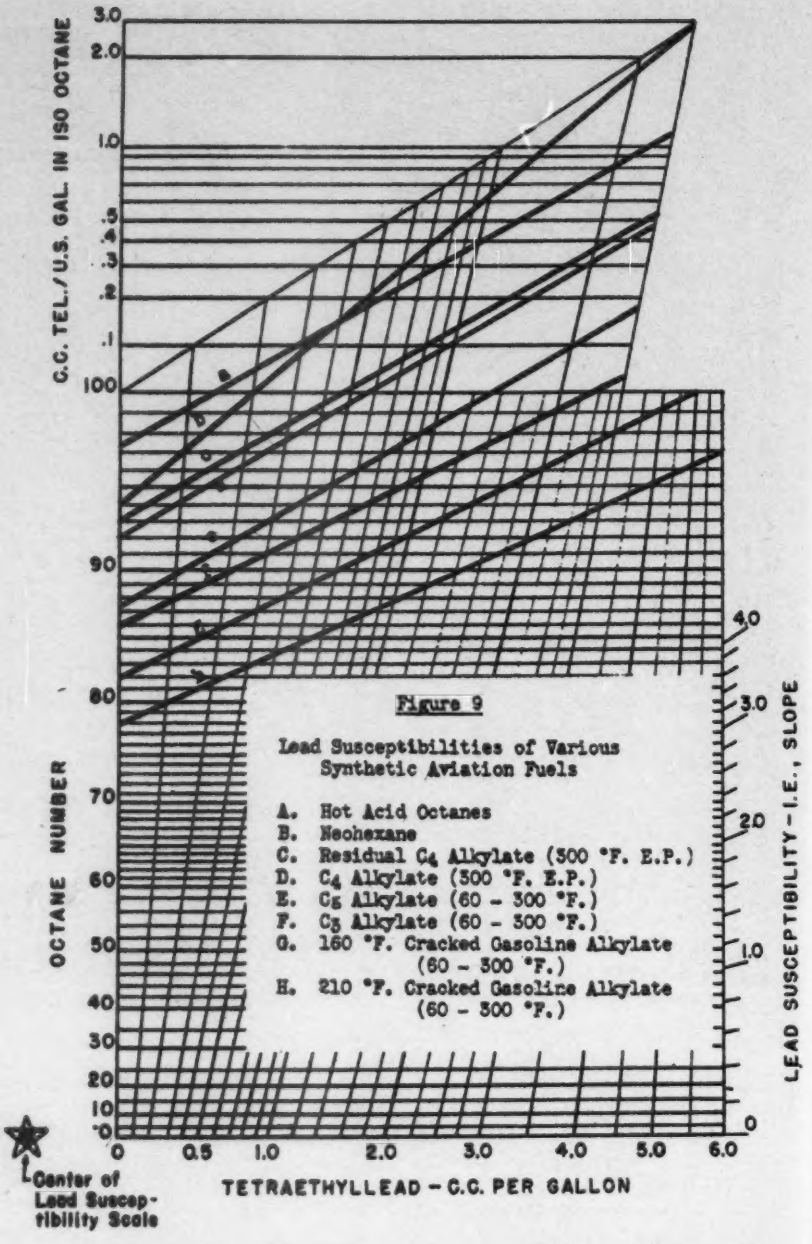

C.C. TEL./U.S. GAL. IN ISO OCTANE
OCTANE NUMBER
LEAD SUSCEPTIBILITY—I.E., SLOPE
TETRAETHYLLEAD—C.C. PER GALLON
A. Hot Acid Octanes
B. Neohexane
C. Residual C4 Alkylate (300 °F. E.P.)
D. C4 Alkylate (300 °F. E.P.)
E. C5 Alkylate (60 - 300 °F.)
F. C5 Alkylate (60 - 300 °F.)
G. 160 °F. Cracked Gasoline Alkylate (60 - 300 °F.)
H. 210 °F. Cracked Gasoline Alkylate (60 - 300 °F.)
Center of Lead Susceptibility Scale

Figure 9

Lead Susceptibilities of Various Synthetic Aviation Fuels

Approximately 88-90% of the polymer is dimer and on hydrogenation this gives a product of 96-97 octane number. Thus it is closely comparable to the Hot Acid Product in quality, provided, as was said, the n-butylenes reacted do not appreciably exceed in quantity the isobutylene reacted. A possible advantage of the U.O.P. process is its flexibility, for whereas the Hot Acid Process is limited to C_4 fraction and up to equal quantities of isobutylene and n-butylenes, the U.O.P. process may utilize a greater proportion of n-butylenes at a sacrifice in octane number. For aviation gasoline this limitation of the Hot Acid Process is not serious but for unhydrogenated motor gasoline the U.O.P. process of polymerization has a definite advantage.

Liquid Phase Prosphoric Acid Process[6]

A closely related process to that of the U.O.P. has been developed by the Standard Oil Company of California. This also used phosphoric acid as a catalyst, but as a liquid rather than impregnated on a carrier. The necessary contact is obtained by passing 100% phosphoric acid over quartz or glazed porcelain filler in a tower at 150-160° C. at atmospheric or relatively low pressures. The yield and quality of product are said to be comparable to that obtained by the solid type of catalyst. A possible advantage is in the ease of regeneration of such a catalyst.

Both this catalyst and that of the U.O.P. require that the feeds be freed of basic material such as amines. Pretreatments with water or dilute acid are provided for their removal.[7]

Polyco Polymerization

One further polymerization process which deserves mention is the Polyco process. A plant has been built by the Standard Oil Company of Ohio[8] and it is understood that others are contemplated. The catalyst used is copper pyrophosphate and it is capable of polymerizing not only butylenes but other olefines as well. While the plant of the Standard Oil Company of Ohio is designed to run on mixed olefinic feed, it is understood that the process is capable of producing from C_4 fraction material of better than 90 octane number after hydrogenation.

A flow sheet of the process is shown in Figure 6. The operating temperature is about 200° C. It will be seen that in principle it is the same as those using other solid catalysts with hydrocarbons in the vapor state.

Thermal polymerization has not been included in this discussion as the pro-

[6] *U.S.P.* 2, 186,021.
[7] *U.S.P.* 2, 186,031.
[8] *Nat. Petroleum News, June 26, 1940, page 230.*

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duct is not comparable with those of the above processes.

From the foregoing, it will be seen that as far as producing isoparaffins of highly branched structure suitable for aviation gasoline is concerned, the field of polymerization is limited to the C_4 fraction and possibly tertiary amylenes present in C_5 fractions. Increasing demands for these products would require processes for the dehydrogenation of the corresponding saturates and considerable progress has been made in this direction, but commercial application of dehydrogenation has been arrested due to the successful application of alkylation processes whereby a paraffin is directly coupled with an olefine to produce a branched chain isoparaffin in a single step.

Alkylation

At the present time there are two successful commercial applications of the alkylation reaction. These are: (1) the catalytic sulphuric acid alkylation process developed by the Anglo-Iranian Oil Company, Humble Oil Company, Standard of New Jersey, Shell and Texas; and (2) the thermal alkylation process of Phillips. Other catalytic processes involving aluminum chloride complex salts show promise but have not yet proved commercially applicable[10].

Sulphuric Acid Alkylation

The sulphuric acid alkylation process has been very well received by the industry and already is supplying large quantities of 100 octane aviation gasoline. Plants capable of producing in excess of 7,200,000 bbls. per year of 92-94 octane number fuel (unleaded) have been built or will be completed in the next few months, and new installations are under consideration. In Table 6 are given the locations and capacities of some of the plants.

While the actual design of some of these plants may differ in detail, in principle they are fundamentally the same. The olefine (usually C_4 fraction) is premixed with an excess of isobutane and then is fed to an emulsion of acid and reacted hydrocarbon which is rich in iso-paraffin but substantially olefine-free. In this way a large excess of isoparaffin is always present in the reaction zone and polymerization or hydropolymerization of the olefines is suppressed.

The actual reaction taking place is rather complicated and involves hydrogen transfer, isomerization and carbon to carbon cleavage, as well as alkylation, but a saturated product of high octane number is obtained in a single step. Thus the process offers distinct advantages over the polymerization hydrogenation reactions previously described.

[9] *Refinery Catalog, Process Section, 6th Ed., 1939, page 399. Gulf Publishing Co.*
[10] *Blunck and Carmody, Baltimore Meeting of A.C.S., April 3-7, 1939.*

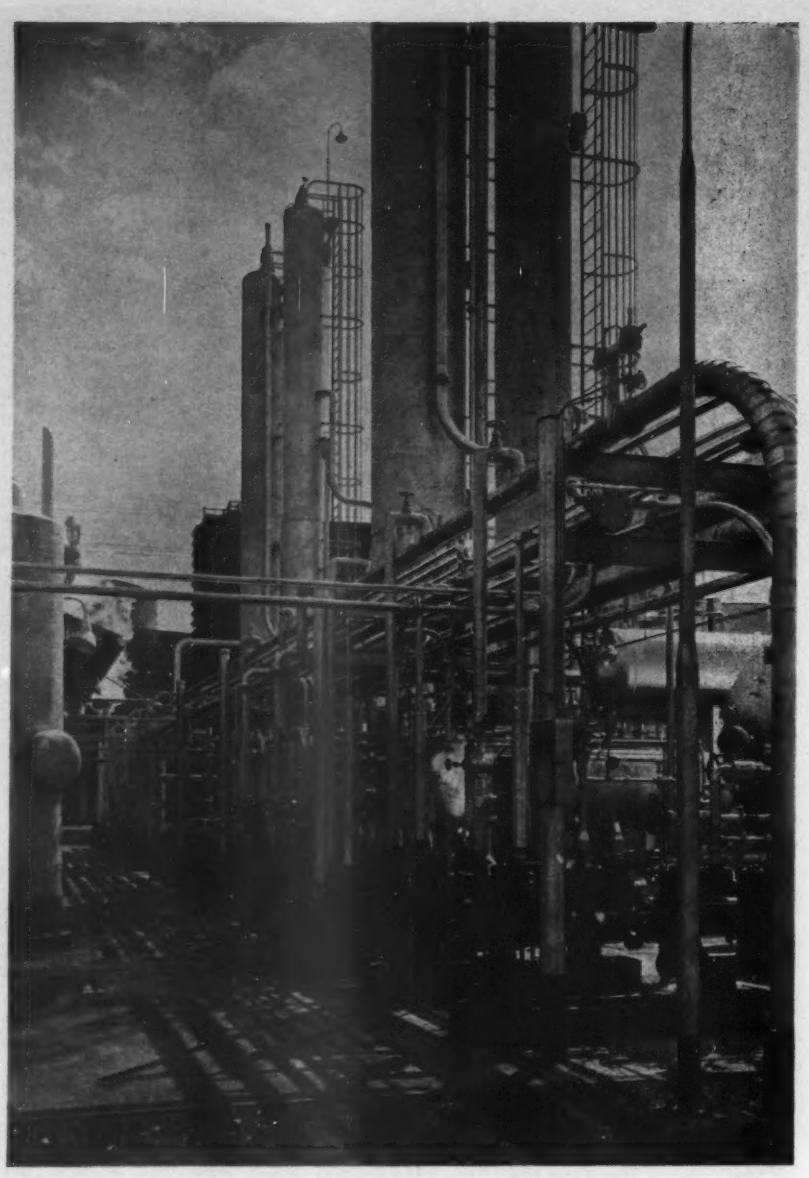

Figure 10

In Figure 7 a flow diagram[11] of a typical plant is shown. It is essential that good mixing be obtained. In this particular design the requisite mixing is achieved by means of a circulating pump acting through additional reaction space in which intimate contact is maintained by the velocity of flow through jets and baffles. An alternative method is to provide a reactor with internal mixing and it is understood that at least one commercial plant has a unit of such design.

Modifications of the single reactors are, of course, possible. Additional reactors may be arranged in series or in parallel and various recycles may be provided from the separator or debutanizer to enhance the olefine dilution effect in the feed. A similar effect can also be obtained by splitting the feed between reactors.

The reacted hydrocarbon is separated from the acid, washed with caustic and stabilized. The excess isobutane is then separated from the n-butane and returned to meet the fresh olefine feed.

Sulphuric acid of from 98 to 100% strength is initially charged to the unit, and the acid is discarded when it reaches a titratable acidity of about 85-88%. Acid may be removed batchwise or continuously. The presence of water, sulphur compounds, amines and dienes in the feed markedly reduces the acid life.

[11] *After paper by Combined Staffs of Anglo-Iranian, Humble, Shell Development, Standard Oil Development, and Texas, presented before A.P.I., Chicago, November 17, 1939.*

A major advantage of the sulphuric acid alkylation process is the great range of possible feed stocks. As has already been pointed out, if 100 octane fuels with reasonable amounts of lead are desired, only C_4 fraction is suitable for polymerization whereas, for alkylation, C_3-C_7 olefines and both isobutane and isopentane can be used. In Tables 7 and 8 are shown the conditions of operation and quality of product produced when alkylating isobutane with a variety of olefine feeds. Distillation curves of the product are shown in Figure 8. Furthermore, by fractionation of the products it is possible to increase the octane number further by eliminating components of poor octane number.

The actual operation of a plant is quite simple and with automatic control instruments, little attention is required. Furthermore, at present the cost of the actual equipment included in the flow diagram is considerably lower than previously published figures.

Figure 9 shows the octane number and lead susceptibilities of a few of the alkylation products as compared to those obtained by either Cold Acid or Hot Acid or U.O.P. selective polymerization, while Table 9 shows the comparative yield based on one gallon of C_4 fraction. From these data it will be readily seen why the alkylation process has been well received by the industry.

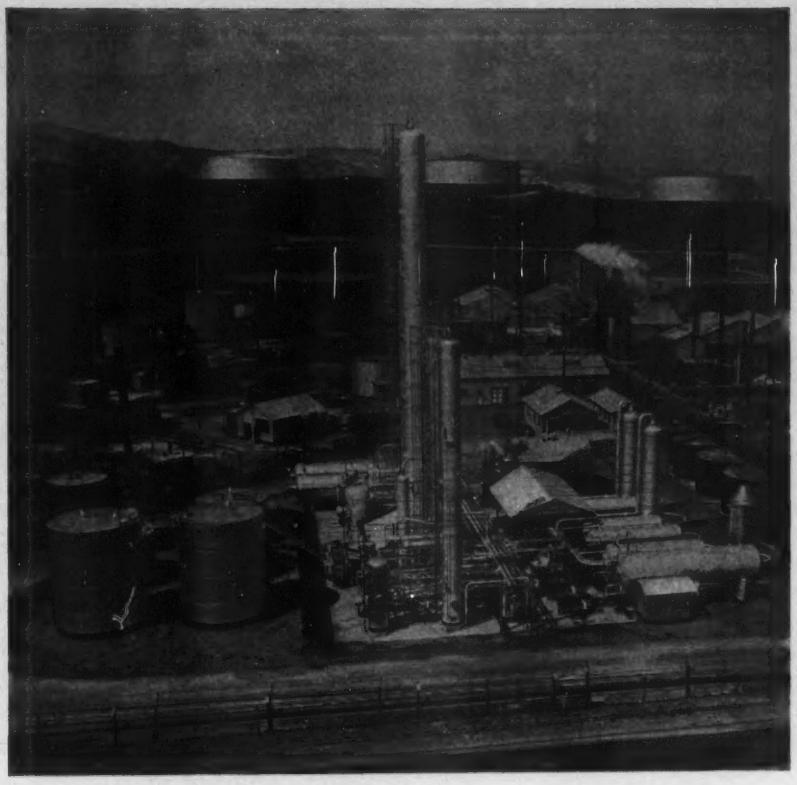

Figure 11

A few commercial installations are shown in Figures 10, 11.

Thermal Alkylation

The sulphuric acid alkylation process is not at present capable of using ethylene or of reacting n-paraffins with olefines, whereas by thermal alkylation this appears to be possible. In fact, according to Oberfell and Frey of Phillips Petroleum[12], the preferred feed stock for thermal alkylation is ethylene and isobutane. When mixed gases are used, the product is of lower quality than that obtained from sulphuric acid alkylation and is primarily suited for motor fuel. Alkylation of isobutane with ethylene, on the other hand, does produce product of high octane number and should be considered in this discussion.

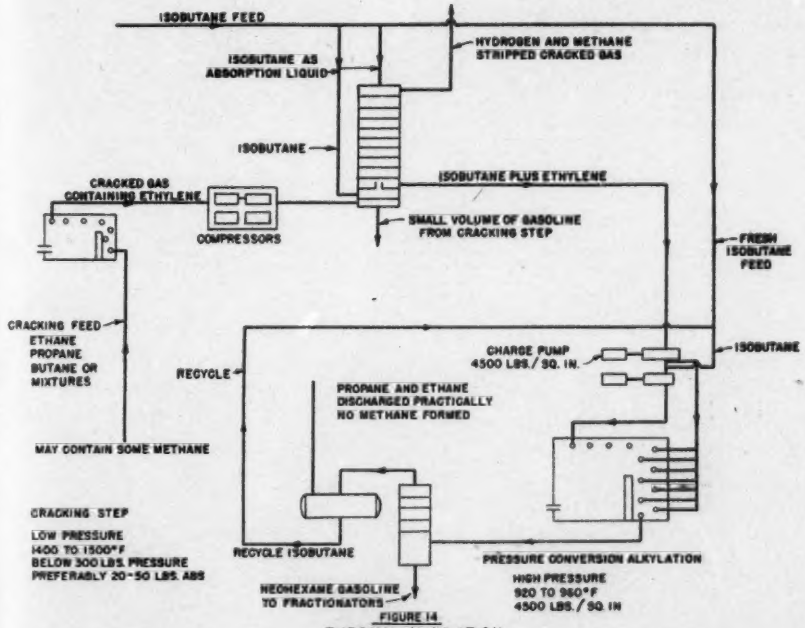
ISOBUTANE FEED
ISOBUTANE AS ABSORPTION LIQUID
HYDROGEN AND METHANE STRIPPED CRACKED GAS
ISOBUTANE
CRACKED GAS CONTAINING ETHYLENE
ISOBUTANE PLUS ETHYLENE
COMPRESSORS
SMALL VOLUME OF GASOLINE FROM CRACKING STEP
FRESH ISOBUTANE FEED
CRACKING FEED ETHANE PROPANE BUTANE OR MIXTURES
RECYCLE
CHARGE PUMP 4500 LBS./SQ. IN.
ISOBUTANE
PROPANE AND ETHANE DISCHARGED PRACTICALLY NO METHANE FORMED
MAY CONTAIN SOME METHANE
CRACKING STEP
LOW PRESSURE 1400 TO 1500°F BELOW 300 LBS. PRESSURE PREFERABLY 20-50 LBS. ABS
RECYCLE ISOBUTANE
PRESSURE CONVERSION ALKYLATION
HIGH PRESSURE 920 TO 960°F 4500 LBS./SQ. IN
NEOHEXANE GASOLINE TO FRACTIONATORS

FIGURE 14
THERMAL ALKYLATION
NEOHEXANE PILOT PLANT

The reaction is carried out in the vapor phase at temperatures of 900° to 1000° F. and pressures of 1000 to 5000 lbs. per sq. in. Under these conditions the reaction is very rapid and the time of contact is only a few seconds. Ethylene is reacted with isobutane in the ratio of 1 to 2 or 3 moles of isobutane per mole of ethylene. Propylene reacts with isobutane at lower temperatures than ethylene, and the butylenes react at still lower temperatures. Thus, by varying the temperature, the reaction can be controlled to produce the desired product.

A flow sheet of a thermal alkylation plant is given in Figure 14[12]. An ethylene-isobutane mixture is pumped to a manifold which distributes it along about ten inlets situated along a tubular coil through which a separate stream of isobutane of greater volume is continually circulated. The reaction temperature is about 510° C. and the pressure between 3000-5000 lbs. per sq. in. The liquid reaction products are condensed out and the unreacted isobutane is recycled in a manner similar to that in sulphuric acid alkylation. In Table 10 the composition of the liquid products is given for a number of representative experiments. In addition, some cracking to lower hydrocarbons occurs, the products of which are not tested.

From these data it will be seen that the product consists of a wide variety of hydrocarbons and is not fully saturated as is the case with sulphuric acid alky-

[12] *Oberfell and Frey, Oil Gas J., 38, No. 28, 50 (1939).*

TABLE 6
CAPACITY OF SULPHURIC ACID ALKYLATION PLANTS

Humble Oil and Refining Company	Baytown, Texas	4,500 bbls./day
Standard Oil Co. of Louisiana	Baton Rouge, La.	1,200
Standard Oil Co. of New Jersey	Bayway, New Jersey	175
Anglo-Iranian Oil Company	Abadan, Iran	100
Shell Oil Company, Inc.	Wood River, Ill.	1,500
Shell Oil Company, Inc.	Houston, Texas	1,500
Shell Oil Company, Inc.	Dominguez, California	800
Shell Oil Company, Inc.	Martinez, California	500
The Texas Company	Port Arthur, Texas	750
Union Oil Company	Wilmington, California	270
Tide Water Associated Oil Company	Avon, California	500
Lago Oil and Transport Company,	Aruba, Neth. West Indies	520
Magnolia Petroleum Company	Beaumont, Texas	2,140
B. P. M. (Shell)	Curacao, Neth. West Indies	750
B. P. M. (Shell)	Palembang, Sumatra	600
N. K. P. M. (Standard-Vacuum)	Palembang, Sumatra	500
Standard Oil Co. of California	Richmond, California*	1,200
Standard Oil Co. of California	El Segundo, California	750
Gulf Oil Company	Port Arthur, Texas	1,000
Richfield Oil Company	Watson, California	350
Sinclair Refining Company	East Chicago, Ill.	400
	Total	20,065

*—Near completion 10/1/40.

lation. This is particularly true for the isobutylene and isobutane reaction. The results obtained with ethylene and isobutane appear to be the most attractive, the weight per cent yield based on ethylene being about 138 as compared to a theoretical yield of 300 weight per cent. Neohexane, 2,2,-dimethyl butane, represents about 42.1% of the liquid products.

In Table 11 are given inspection data on the products of the alkylation of isobutane by ethylene[13]. It will be seen that the crude alkylate has an octane number of only 82.5 and after separating out the neohexane fraction this drops to 78.4. Sample C represents product obtained by blending the neohexane fraction with the rest of the C_7 and C_8 alkylate and then adding 3 cc. of lead.

The most important property of neohexane is its lead susceptibility. This is compared with isooctane in Table 12[14]. As may be seen, neohexane shows a definitely higher lead susceptibility.

Attempts have been made to compare thermal alkylation with sulphuric acid alkylation. This is, of course, impossible on the basis of the ethylene-isobutane reaction product as sulphuric acid alkylation is not applicable to ethylene. With higher olefines and isoparaffins sulphuric acid alkylation appears to be definitely the superior. Furthermore, the use of lower temperatures and pressures and a cheap catalyst should make the initial cost and operating costs lower.

The overall efficiency of the thermal process for ethylene and isobutane still leaves much to be desired and undoubtedly a catalytic process by accelerating the reaction and allowing lower temperatures and pressures would lead to a considerable improvement.

The direction of the next step in the production of synthetic fuels is not known but it is safe to predict that the future holds much of promise.

Conclusion

The application of chemical research to petroleum refining during the past six years has brought about enormous ad-

[13] *Oberfell and Frey, Oil Gas J., 38, No. 29, 70 (1939).*
[14] *Ibid, page 73.*

TABLE 7
ALKYLATION WITH REPRESENTATIVE REFINERY OLEFIN FEED STOCKS

Olefin Feed Stock (Per Cent by Weight of Olefin)	C_3 Fraction from Cracking 38*	C_4 Fraction from Cracking 48†	Residual C_4 Fraction from Isooctane Manufacture 24‡	C_5 Fraction from Cracking 55	70— to 160— Deg. F. End-Point Cracked Gasoline 52	70— to 210— Deg. F. End-Point Cracked Gasoline 50
Conditions:						
Isoparaffin used	Isobutane	Isobutane	Isobutane	Isobutane	Isobutane	Isobutane
Mole Ratio of isoparaffin to olefin	8	5	5	8	8	8
Makeup acid strength, per cent by weight of sulphuric acid	98–100	98–100	98–100	98–100	98–100	98–100
Volume ratio of acid to hydrocarbon ratio	1	1	1	1	1	1
Temperature, deg. F	85	32–50	32–50	50	50	50
Contact time, min.	20–40	20–40	20–40	20–40	20–40	20–40
Titratable acidity of rejected acid, as per cent by weight of sulphuric acid	88–90	88–90	88–90	88–90	88–90	88–90
Per cent by weight of yield of total alkylate based on olefin in feed	185	190–200	200–215	134‖	126‖	115‖
Per cent by volume of total alkylate based on olefin in feed	138	158–166	168–180	125‖	119‖	113‖
Aviation fraction (end point, 300 deg.F.) in total alkylate, per cent	92–95	88–90	80–91	90	85	77
Makeup acid, lb. per gal. of total alkylate	2.6	1	<1	1.5	1.7	3.3

*—With mixed C_3 and C_4 fractions, materially better results are obtained.
†—About 18 per cent isobutylene present.
‡—Largely butylene-2.
‖—Yield based on total refinery fraction, which includes saturates.

TABLE 8
PROPERTIES OF PRODUCTS FROM ALKYLATION WITH REPRESENTATIVE REFINERY OLEFIN FEED STOCKS

Olefin Feed Stock	C_3 Fraction from Cracking	C_4 Fraction from Cracking	Residual C_4 Fraction from Isooctane Manufacture	C_5 Fraction from Cracking	70 —to 160— Deg. F. End-Point Cracked Gasoline	70— to 210— Deg. F. End-Point Cracked Gasoline
Isoparaffin Used	Isobutane	Isobutane	Isobutane	Isobutane*	Isobutane*	Isobutane*
Properties of total alkylate (C_4-free): Gravity, deg. A.P.I.	72.1	69.2	69.2	76.6	72.1	70.6
Bromine No., g. of bromine per 100 ml.	0.1–0.4	0.3–0.5	0.3–0.5	0.5–1.0	0.5–1.0	1–2
Sulphur, per cent	0.001	<0.001	<0.001	<0.005	<0.005	<0.005
Reid vapor pressure, lb. per sq. in.	4	.....	3	8	.....	.....
Octane No. (A.S.T.M.-CFR)	88.0	91.5	92.5	87.0	83.0	79.0
A.S.T.M. Distillation, in Deg. F.:						
Initial boiling point	152	120	117	108	126	128
End point	387	403	378	446	455	414
10-per-cent point	180	182	183	144	158	162
20-per-cent point	185	199	203	164	169	176
30-per-cent point	189	209	213	191	183	190
40-per-cent point	192	217	221	222	201	208
50-per-cent point	194	222	225	242	220	220
60-per-cent point	198	230	228	253	236	236
70-per-cent point	202	235	231	261	250	248
80-per-cent point	212	242	236	277	270	266
90-per-cent point	271	267	250	306	316	328
95-per-cent point	345	340	314	368	374	385
Recovery, per cent	98	99	96.5	99	98	98
Recovered at 266 deg. F., per cent	88	89.5	92	79	76	70
Properties of 300 deg. F. end point fraction:						
Unsaturation, per cent	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Sulphur, per cent	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
50-per-cent point, deg. F.	190	220	221	209	200	205
Reid vapor pressure, lb. per sq. in.	.....	3.5	3.0	9.0	11.6	7.4
Octane No. (A.S.T.M.-CFR)	89	92	93	87	82	78

*—Products not depentanised.

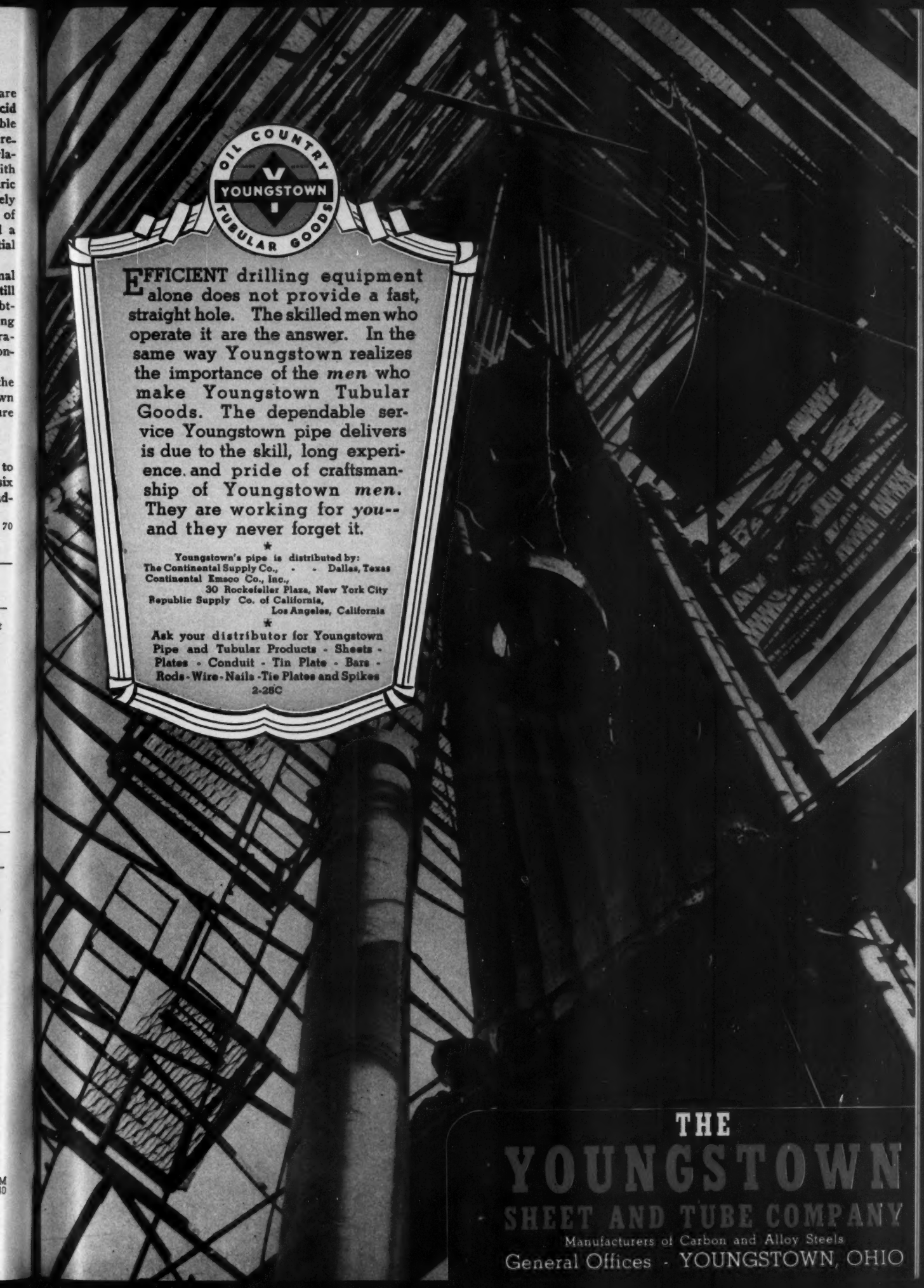
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TABLE 9
COMPARISON OF ALKYLATION AND POLYMERIZATION FOR C_4 FRACTION FROM CRACKING
(Basis, 1 Gal. of Feed)

Feed Composition, per cent by volume.

Propane	1
Isobutylene	18
n-Butylenes	30
Isobutane	9‖
n-Butane	42
Total	100

Method Used	Cold-Acid Absorption and Polymerization Plus Hydrogenation	Catalytic Polymerization Plus Hydrogenation*	Catalytic High-Pressure Polymerization Plus Hydrogenation†	Alkylation
Additional isobutane, gallons/gal. of feed	Nil	Nil	Nil	0.42
Product‡ boiling below 300 deg. F., gals.	0.11	0.25	0.32	0.73
Octane No. of saturated aviation cut (A.S.T.M.—CFR)	99–100	96–98	91–93	92–94
Gallons of 87 – octane fuel per gallon of feed prepared by blending aviation cut with 72 – octane base stock§	0.21	0.42	0.43	1.02

*—Either U.O.P. or hot-acid process operating for maximum octane number.
†—Operating for maximum yield.
‡—Data are approximate. The yield depends somewhat on operating conditions.
§—Assuming straight-line function and motor-method octane numbers.
‖—In general, refinery streams are richer in isobutane.

TABLE 10
PRODUCTS FROM THERMAL ALKYLATION

Reactants (Per cent)*	C_2H_4 8.9 C_3H_8 91.0	C_2H_4 11.8 Iso-C_4H_{10} 88.2	C_2H_4 25.6 Iso-C_4H_{10} 74.4	Iso-C_4H_8 8.2 Iso-C_4H_{10} 91.8
Conditions				
Pressure (lb./sq. in.)	4,500	4,500	4,500	8,000
Temperature, °C.	510	515	505	486
Total Reaction Time (min.)	4.1	2.2	4	3.2
Results				
No. of Olefine Additions	20	14	10	10
Gasoline Yield Based on Total Products	11.2	14.8	35.4	2.9
Analysis of Liquid Products				
C_4H_{10}	2.6	1.9	2.2	6.5
Iso-C_5H_{12}	55.1	5.0	3.1	3.6
n-C_5H_{12}	16.2		2.7	
C_6H_{12}	1.9	5.2	2.7	1.6
2, 2-Dimethylbutane	7.1	42.1	31.3	
2, 3-Dimethylbutane				
2 Methyl Pentane		17.5	9.9	2.6
n-Hexane				
C_7H_{16}	1.8	2.4	2.0	3.2
C_7H_{14}	10.0	4.1	4.1	4.2
C_8H_{18}	1.0	3.2	2.9	32.7
C_8H_{16}	3.3	12.7	13.7	34.0
C_9+ to 200°C.	1.0	4.8	17.4	11.6
Heavier		1.1	8.0	
Total	100.0	100.0	100.0	100.0

*—All percentages are by weight.

TABLE 11
INSPECTION DATA FOR PRODUCTS FROM THERMAL ALKYLATION OF ISOBUTANE WITH ETHYLENE

Sample Descriptions	A Debutanized Alkylate	B A, Minus Neo-Hexane Content	C* Neohexane Volatility	D** Plus Lower Fraction
Octane Number (A.S.T.M.)	82.5	78.4	100.2	99.6
A. P. I. Gravity at 60°F.	73.2	67.7	76.6	75.6
Reid Vapor Pressure, lb. per sq. in.	7.3	6.9	6.9	6.4
A.S.T.M. Distillation per cent Evap. at °F.				
First drop	118	116	128	120
5	129	136	134	139
10	136	149	139	146
20	142	158	143	150
30	146	166	146	154
40	151	175	151	160
50	157	186	156	164
60	166	199	166	176
70	180	215	179	193
80	206	236	200	209
90	268	273	217	221
95	310	325	222	230
End point	370	399	258	282
Sum of 10+50 Per Cent Points			295	310

*—A blend of 40 volumes of acid treated C_7-C_8 fraction (165-243°F.) with 60 volumes of neohexane fraction. Octane Rating is by A.S.T.M. method with 3 cc. T.E.L. per gallon.
**—A blend of 50 volumes of acid treated C_7-C_8 fraction (165-243°F.) with 50 volumes of neohexane fraction. Octane Rating is by Army Method with 3 cc. T.E.L. per gallon.

TABLE 12
COMPARISON OF OCTANE NUMBER AND LEAD SUSCEPTIBILITY OF ISOOCTANE AND NEOHEXANE

	Octane Number (A.S.T.M. Method)	T.E.L. Requirements to Equal C.P. Isooctane plus Indicated T.E.L. (A.S.T.M.) Method			
		0.0 cc.	1.0 cc.	2.0 cc.	3.0 cc.
Neohexane (90 Per Cent Pure)	94	0.25	1.35	2.25	3.0
Isooctane—Normal Heptane Blend	94	0.30	2.90	4.85	6.35

vances in the production of synthetic aviation fuels of high octane number. At the present time there are available processes which can, by expansion to their known limitations, supply very large quantities of aviation fuel of better than 90 octane number with 3 cc. of lead. Thus the petroleum industry is prepared to meet the requirements of this nation for defense in the air. Furthermore, these processes represent true conservation in that they have turned gaseous by-products which formerly were of little value into very useful substances.

Commercial Butane, a Waste Material,

Becomes a Premium Product

C. N. G. A. 1940 FALL MEETING

By Charles E. McCartney,
Petrolane, Ltd.

It is only necessary for producers to look back a short time, to when kerosene was the marketable product and gasoline was the waste material, to realize that the waste materials of yesterday often become the premium products of tomorrow.

Fifteen years ago, absorption plants were faced with the problem of discarding their excess reflux. Some small quantities of this material were being distributed in California for household purposes, and some manufacturers were experimenting with uses and methods of handling, but no appreciable market had been established.

This excess reflux was a combination of all of the paraffin hydrocarbons from Methane to the heavy ends. In those days, there seemed to be no limit to the heaviness of the ends, except that it was water-white, and over half of it would boil off at normal temperatures. Water entrained and in solution was another source of trouble.

The first distributions of so-called commercial Butanes were made in small tanks manufactured by various water-heater companies. They conformed to no code. The valves and fittings were intended for every conceivable purpose other than Liquefied Petroleum Gas use. It was not uncommon to have the tanks one-third full of heavy ends and water after the gas had stopped coming off. A pressure gauge would give the consumer a good idea of how much gas he had left, because the pressure varied as the fractionation in the tank progressed. Due to the varying BTU's of the fractions, the stove burners were hard to light when the tank was full, and smoked when near the end. Constant manipulation of the primary air was necessary in order to make the appliances operate at all. In spite of all of these drawbacks, the price of the fuel was 15c per pound, or about 65c per gallon to the consumer. (Certainly a premium fuel.)

The industry was making great strides in fractionation and absorption, and the quality of this fuel rapidly improved. The larger producers recognized a profitable market for a waste material, and pure Propane as a bottled gas made its appearance in California. This Propane was marketed with a progressive and constructive sales plan, without the price-cutting which was so prevalent in the commercial Butane field, and today the Propane market is increasing more rapidly in the United States than the Butane market, at a consumer price almost ten times that of the Butanes.

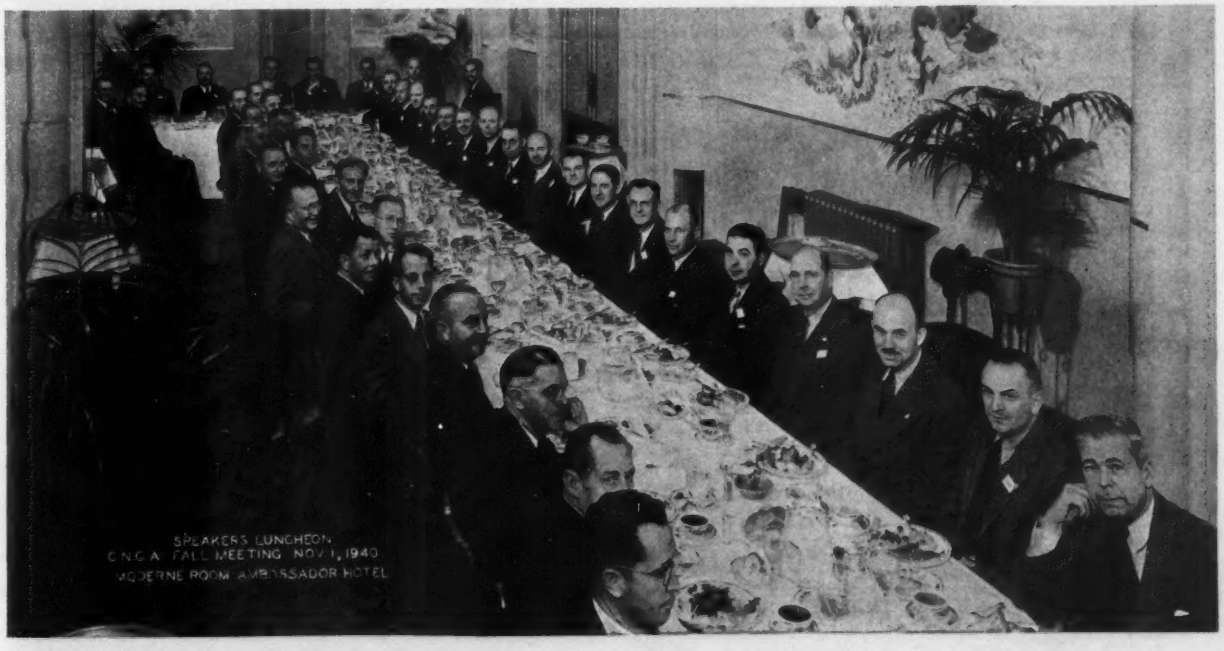
The marketing of Propane gave rise to a greater problem in the plant operation, because in capturing the Propane in the excess reflux, the quantity of residue or commercial Butane was greatly increased, and the disposal of this material in large quantities presented quite a chore.

A fertile field for distribution was quite evident from the successful operation of the first gas plant at Moorpark, and a drive to equip similar towns began. Also, studies were made of enrichment of oil gas for city consumption.

Butanes-Gas Oil Comparison

Normal small oil gas plant operation had a manufactured gas cost of about 72c per thousand to holder. A comparable gas could be made by diluting commercial Butane vapors with air. The cost of diluting the vapors was about 5c per thousand, leaving a balance of 67c to be allocated to the cost of the Butane. The vapor from 5½ gallons of Butanes, when blended with the proper amount of air, will make 1,000 cubic feet of a gas equivalent in heat content to 550-BTU oil gas. Hence, the Butanes had an economic value in this field of 12c per gallon in competition with gas oil. In larger operations, this economic value figured as low as 6c per gallon. This premium fuel is now sold at one-half this lower value.

In new gas plant operation, Butanes were cleaner and the initial investment was much smaller. Undiluted vapors could be distributed on a therm or pound basis to compensate for the higher heat value. Many plants of this type were installed, but the pioneering and sales expense was quite high, and the pioneer rarely reaped the reward for his labors, as plant operators with excess Butanes and without sales expense were able to undersell the developers of the market. They sold on the basis that a sale at any price was better than blowing this waste material to the air. Prices were quoted as low as 2c per gallon. This near-sighted policy tended to slow up rather than increase sales for this type of operation. In this field, education and constructive selling were necessary to expansion, and price was a secondary consideration. At the prices quoted, there could be no allowance for the required sales promotion and education; and the goose, that was a potential layer of golden eggs, was killed.



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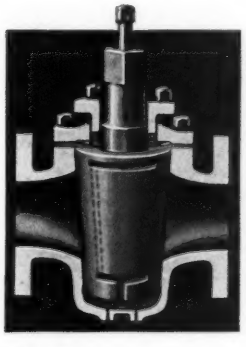
...it can't be done! Stand an egg on end? *Preposterous!* But Columbus was unperturbed. He deftly brough. the egg down on the table, cracking it slig.htly at the bottom. The skeptics were amazed, for *there it stood.* ¶ Instinctively, it seems, Nordstrom Valve engineers have the knack of doing the *impossible.* Miracle valve accomplishments have been attained again and again as a result of Nordstrom ingenuity and initiative. *For instance:* Nordstrom pioneered the first successful lubricated plug valve. Nordstrom has built the largest plug valves, (30″). Nordstrom has developed the only types of valves with lubricants capable of operating at temperatures of 950° F. Nordstrom brought forth Hypreseal, the only plug valve that can take test pressures up to 15,000 lbs. per square inch. Nordstrom introduced new brittle-resistant alloys for temperatures of -150°. And again Nordstrom has cast precedent aside by *Merchroming* valve plugs and bodies with a continuous hard-facing for use in high temperature service and for corrosive and erosive conditions. The "toughest jobs" eventually come to Nordstrom; proof enough these valves meet *all* your needs.



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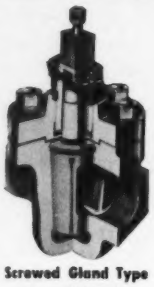
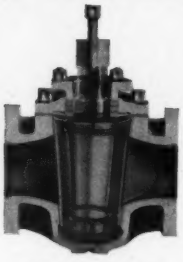
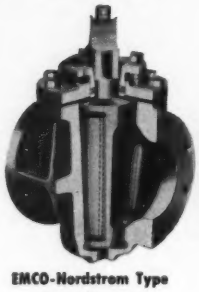


Screwed Gland Type
4" and Smaller



Bolted Gland Type
4" and Larger



EMCO-Nordstrom Type
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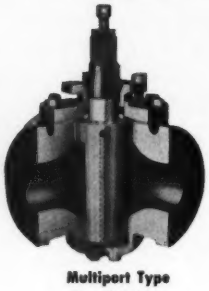
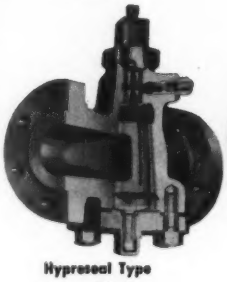
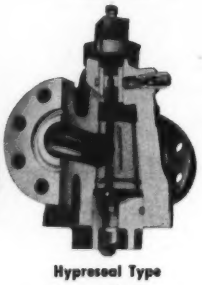


Multiport Type
3 and 4-Way



Hypreseal Type
Flanged Bottom
Rectangular Opening



Hypreseal Type
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Round Opening

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Combustion Engine Use

The marketers who were attempting to build a legitimate profitable business were driven into other fields where some investment as well as promotion work was required. This investment on the part of the marketer was in tankage and delivery equipment, and amounted to a large enough item to deter the price-cutters. The farming areas had a large potential use in tractors and pump engines, and commercial Butane had many advantages over other fuel for this purpose.

Early in the development of Butane as a motor fuel, comparative tests were made to determine its economic value in competition with other fuels.

In order to understand the following test results, it might be well to consider its characteristics as a motor fuel:

Butane is carbureted in a vapor form which allows finer adjustment of the mixture than with gasoline and precludes entrained liquid from reaching the cylinder. Therefore, all heat can be removed from the intake manifold, thus adding to the thermal efficiency of the engine. Its volatility prevents condensation of hydrocarbons on the cylinder wall and resultant crankcase dilution. Combined with a small percentage of Propane, it has an octane rating of 100, and will therefore stand a higher compression ratio without detonation. Its slow burning feature changes the torque curve of straight-run gasoline so that a greater torque is generated and the curve peaks at slower speeds—thus creating an increased horsepower from normal operating speeds downward. Thus the efficiency of this fuel increases inversely with the speed of the motor and directly with the length of the stroke; in other words, the increase in efficiency is greatest in long-stroke, slow-speed engines such as tractors, heavy duty trucks and power engines, while on pleasure cars and like equipment, the smaller thermal content of a gallon of Butanes becomes apparent, and the mileage per gallon should be less than with gasoline, although the engine should run smoother. This thermal content of a gallon of Butane is about 20% less than that of a gallon of gasoline, and in short-stroke high-speed engines it is impossible to overcome this handicap.

Gasoline Comparison

In order to show the competitive value of Butane and gasoline, a demonstration was made using two large tractor units of the same type and size—one with gasoline, and the other converted to Butane, with higher compression. In checking the operating results as close as possible, it was found that the Butane showed a 20% to 25% gallonage saving at the same load, or would develop about 20% to 25% additional power if desired. Although an attempt was made to have these two units exactly alike as to mechanical conditions, there was some slight advantage to the Butane due to the higher compression of the motor. Later operations have shown about the same results as the original tests. Hence, on large gasoline tractors an increase of power or a fuel saving of 20% to 25% can be expected when properly converted to Butanes.

There is another advantage to the use of this fuel, and that is that theft is practically impossible and there is not the large unaccounted-for loss shown by gasoline which probably finds its way into private cars. The absence of this loss in many cases has made the Butane show a greater saving than is possible due to the increased efficiency of the fuel alone.

The conclusion must be drawn that Butanes have a competitive value of 20% to 25% more than third structure gasoline on all types of large tractors, whether on the farm or in construction work. Why, then, should Butane—a premium fuel—be sold for so much less in actual competition?

Diesel Comparison

To prove the value of Butane in competition with Diesel fuel, one of several tractors built for and burning Diesel fuel was converted to Butane by removing the injector and reversing the intake manifold to allow for a Butane downdraft carburetor. A large field was checkerboarded so that each tractor would operate under identical conditions. The Butane-equipped unit plowed about 20 acres per shift to 14 for the Diesel units. The operation of this equipment was a perfect demonstration of the increased torque of Butane at low speeds. Whenever a hard spot or irrigation border in the field was encountered, the Diesel driver had to shift gears in order to compensate for the increased load, but the Butane unit carried through, thus gaining several yards every few minutes.

The operator figured his labor and fuel

cost as 36c per acre for the Butane unit and 42c for the other units. You will note that the Butane unit cost slightly more per shift to operate, but it did a lot more work.

This operator figured his cost on the basis of 5c Diesel fuel and 8c Butane, which leads to the conclusion that the labor is more of a factor than the fuel, and that Butane has an economic value more than 50% higher than Diesel fuel in all operations where Diesel tractors can be used. This being true, why then is Butane, a premium fuel, sold for less?

Electrical Power Comparison

A test was made in the San Joaquin Valley with a pump engine of standard design, compressioned for Butane. This equipment required .35 pounds of Butanes to develop 1 brake horsepower hour, or .452 pounds to produce the equivalent of 1 kilowatt hour. In this case, the user was paying $14.00 per horsepower per year standby, and 8c per kilowatt hour for his power. Allowing the $14.00 for oil, grease, write-off, and repairs (above the requirements of the electric motor), we find that a fuel cost of practically 6c per gallon will equal the 8 mills power cost.

The oil, grease, write-off and repairs can be handled for much less than the $14.00 per horsepower per year as allowed, and therefore the economic value of the Butane in this case was more than 6c per gallon. At this price, the profit to the consumer warranted the additional investment required to replace the electric motor.

These tests prove the value of Butane as a premium fuel for the operation of all types of power units whether on the farm or in industrial plants, and constructive selling methods should make this price obtainable.

Reformation

There has been much discussion as to the reformation of large quantities of commercial Butane into high-grade aviation gasoline by means of alkylation and other processes. In order to determine the soundness of this program, the value of the product in its natural state must be weighed against its value as a charging stock in the manufacture of another fuel. No problem would arise if it were not for the volatility of the Butanes in the natural state, because if Butanes were a liquid at normal temperatures and pressure, we would not even be able to supply a portion of the demand. It can be said that the vapor pressure of this fuel and its limited supply are the only deterrents to its universal use. It answers practically all of the requirements of a perfect motor fuel except for its high vapor pressure.

With tank manufacturing methods and values and fittings improving daily, the cost of handling this volatile material is rapidly decreasing.

On long-haul operations, deliveries of Butanes can now be made at the same cost per gallon as gasoline. On small dumps, however, the delivery costs are slightly higher. Educational and service costs are also dropping rapidly as the consuming public becomes familiar with the product.

With a constructive sales program, markets could be found where the premium value of this fuel would warrant a premium price and where the slight additional cost of handling would be a minor item.

The large supply of butanes in the refineries leads to the assumption that only the iso-butane from the natural gasoline plant operation will be called upon to round out the alkylation of these refinery products, thus leaving the excess normal Butane and Propane for the commercial Butane markets. This normal

Left: C. S. Beard, C. C. M. O. Co., Chairman, CNGA Taft Chapter; M. M. McMahon, Southern California Gas Co., Secretary, CNGA Taft Chapter, 1940-41.

Butane can be blended with a small percentage of Propane to make a commercial Butane usable for practically all present uses, with the possible exception of bottled gas.

This course would appear to be a sound one, and present indications are that large quantities of iso-Butane will be so used, with the resultant curtailment of the commercial Butanes available. The quantities thus removed from the existing market will have a stiffening effect on the present price and bring about a seller's market earlier than could be expected from existing statistics.

From the present outlook, it would be a logical step to remove the iso-Butane from the commercial Butane market and use it as a charging stock in the alkylation of the refinery butanes, but the resultant stiffening of the Butane market should limit this withdrawal by increasing the value of this product in its raw state to a point where it would not be economically sound to use it all for alkylation processes, or go to the expense of reformation merely to reduce its volatility.

To those who lift their eyebrows to this conclusion, it is only necessary to call attention to the Propane market in small cylinders. Here was a planned sales program and a more or less controlled market without so-called dumping. This market today is increasing faster throughout the United States than the Butane market, and the average price of this fuel to the consumer is about 6c per pound, or 26c per gallon; certainly a value greater than could be obtained from charging stock.

Conclusions: From the above tests and comparisons of value, we are forced to the following conclusions:

1. That commercial Butane has a much greater competitive economic value than the present market indicates.
2. That it should be considered a valuable product and not a waste material, and as such should carry its proportional share of overhead, sales and operating costs.
3. That it has a potential user value greater than third structure gasoline in heavy duty equipment.
4. That it has an economic value more than 50% higher than Diesel fuel.
5. That with proper marketing this product would become a premium fuel for many types of equipment and in many operations.
6. That in figuring the use of commercial Butanes for alkylation and chemical processes, the present market value should not be used as a yardstick, but a potential economic value should be used. This value will become immediately apparent when a seller's market is reached.

Marketing Problems

There may be several answers to the question of why, if all these conclusions are correct, this premium fuel has not taken its proper place in the industry. The most evident answer is the one of supply and demand, but constructive selling and a well-developed marketing plan would have brought about a seller's market by this time if some such plan had been in force. Unfortunately, Butane has in most cases been treated as a stepchild, and no department wanted the task of building up a market for it. Hence the whole marketing problem was thrown in the lap of the Natural Gas department men who did not have any experience in retail marketing and were not equipped to handle it. The result was that Joe Doakes could drive up in a truck and, by paying practically nothing, pick up a load of Butanes and deliver it to someone else's customer at half price. This pirating became the accepted practice, and a great deal of this type of business is going on today and will continue so long as the manufacturing department, without any set selling plan, will deliver to practically any Tom, Dick or Harry who drives up in a truck and pays for the fuel—generally with a rubber check! This practice must be stopped if this industry is to progress and become a legitimate, revenue-producing part of the petroleum industry.

In summing up the marketing of com-

C.N.G.A. 1940 Fall Meeting Morning Speakers: Left to Right: Harold W. Washburn, Research Dept., United Geophysical Co.; D. A. Smith, Tide Water Associated Oil Co.; M. W. Kibre, General Petroleum Corp.; T. L. Taggart, Standard Oil Co. (Chairman); F. N. Laird, The Texas Company; C. B. Heartwell, Standard Oil Co.

mercial Butane in the past, it might be said that except for short periods it has been a process of dumping an unwanted waste material rather than the constructive selling of a valuable product which could carry its share of the costs and overhead of this industry.

The Future Outlook

The next few years are important ones in commercial Butane business, because the supply of the natural product is limited and we are approaching the point where the readily available will not supply the immediate demand, and in order to increase production, further investment will have to be made. When this happens, Butanes will be called upon to bear their proportionate share of the overhead and manufacturing costs—in other words, they will become a legitimate product and should be sold at a price commensurate with their actual value, with a constructive, progressive sales program.

In order to lay out such a sales program, it might be well to consider the volume of sales and readily-available material in order to determine when a seller's market will be reached.

According to the Bureau of Mines, about 50 million gallons of natural gasoline are produced each month in California. Allowing 15% of this amount to be considered as commercial Butanes, a total of 7½ million gallons per month is apparently available. A considerable portion of this total, however, cannot be considered readily available without additional investment in storage and equipment. A rough check leads to the conclusion that about 20% of the total available is in this category. If this is true, 5½ million gallons per month can be considered readily available in California.

The sales in this area were slightly less than 3 million gallons per month in 1938, and increased to over 4 million gallons per month in 1939. This increase seems to be continuing at a greatly accelerated rate, as estimates from statistics of the Bureau of Mines for the first five months of 1940 show a nine-million-gallon gain over the corresponding period of 1939. From these figures, the conclusion must be drawn that a seller's market is rapidly approaching.

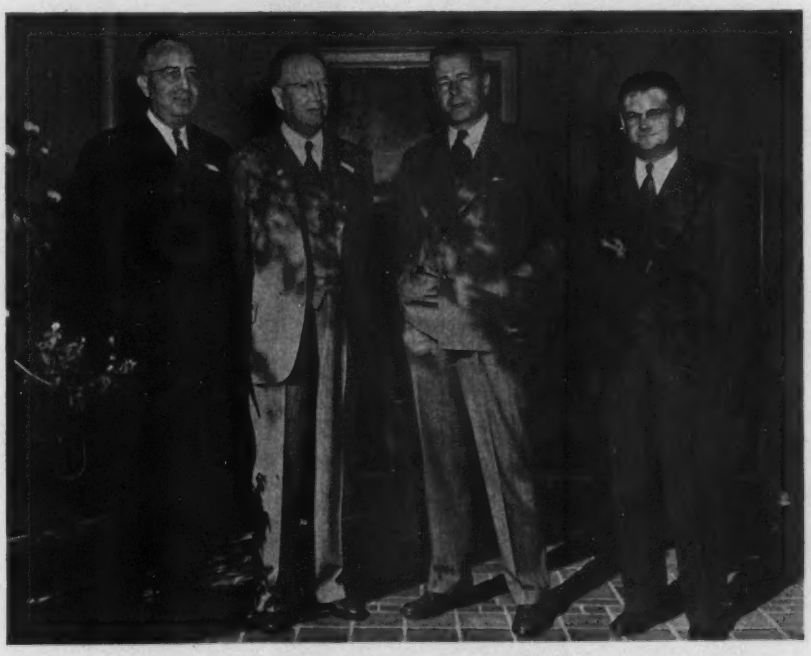
Using the 5½ million gallons per month readily available, and deducting the 4 million gallons of sales per month in 1939—it becomes apparent that if the sales in 1940 increase only 1½ million gallons per month, an exact balance will be reached this year—without considering the requirements of the alkylation processes. In fact, a seller's market would now be apparent if the refineries had not added to the natural supply by using their still vapors. This paper deals only with the natural supply, but in prognosticating the future outlook, this refinery source must not be overlooked.

No definite figures seem to be available as to the amount readily obtainable or the quality of this product from refinery vapors. However, the Bureau of Mines sets the sale of liquefied petroleum gases in this area at roughly 7 million gallons for the month of September, 1940: 4 million gallons from the natural gasoline plants direct, and 3 million from the refineries. It can be estimated that 50% of the refinery production is from natural gasoline plant origin. Thus, in September of this year, roughly, a total of 5½ million gallons of natural product was sold.

Estimating that the alkylation processes will require all of the iso-Butanes in the readily-available commercial Butanes, and assuming that the iso-Butane amounts to 20% of the total, a production of about 8 million gallons of liquefied petroleum gases per month should be required to fill the demand in 1941. The industry is therefore faced with the problem of increasing the estimated readily-available by 2½ million gallons per month, with the resultant additional investment in storage and equipment, and the refineries will be called upon to supply larger and larger quantities from their still vapors as the sales increase.

Some leeway has been taken with these figures to demonstrate a possibility rather

(Continued on Page 42)



C.N.G.A. 1940 Fall Meeting, Afternoon Speakers: Left to Right: C. E. McCartney, Petrolane, Ltd.; Henry N. Wade, Parkhill-Wade; O. C. Field, O. C. Field Gasoline Corp. (Chairman); S. H. McAllister, Shell Development Co.

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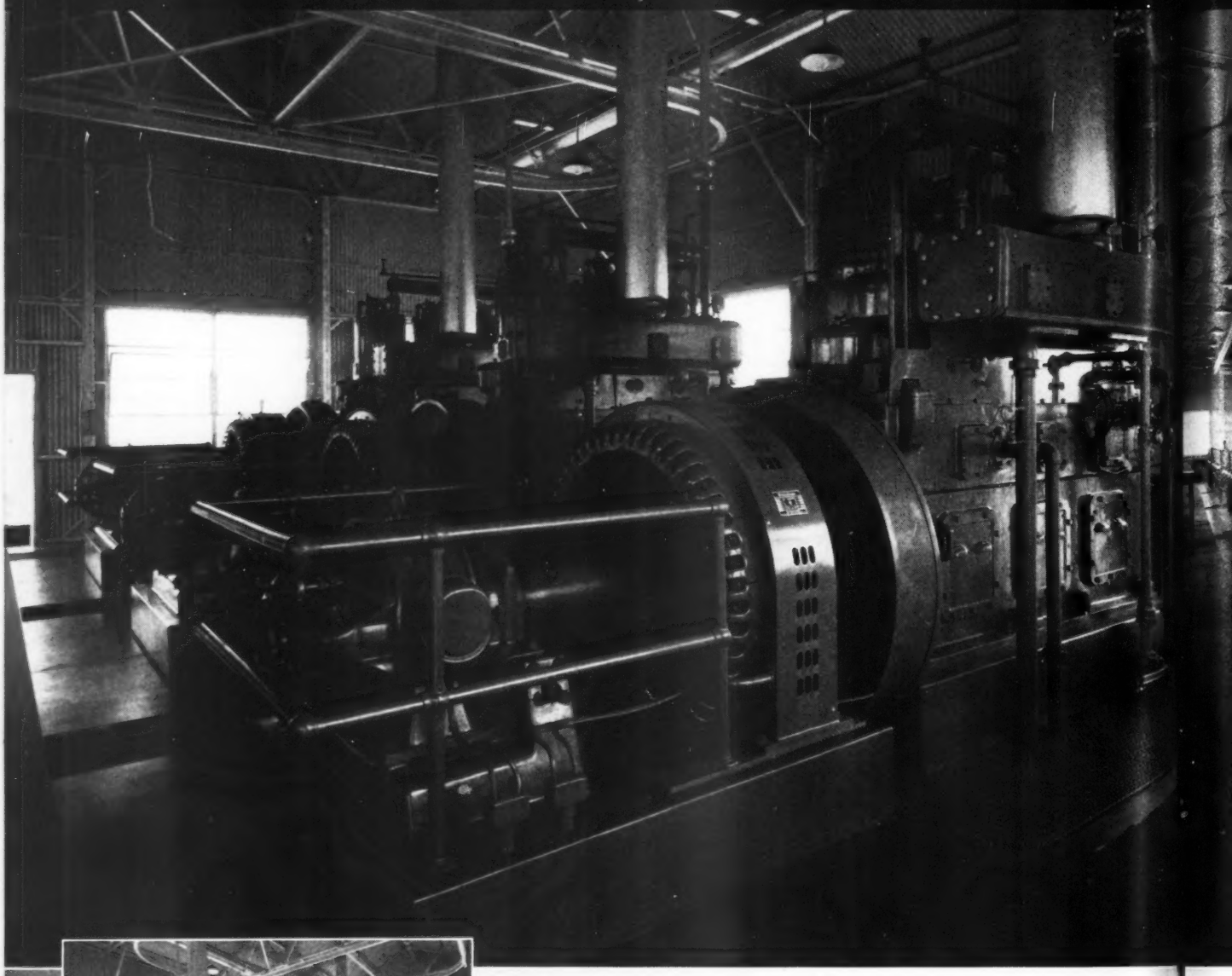

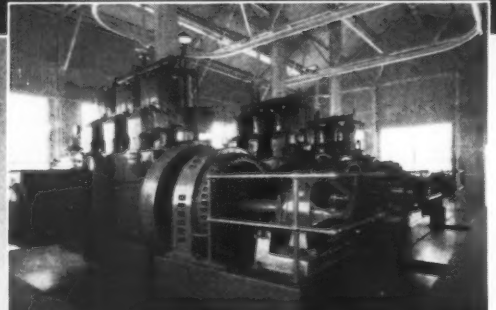

Photographs show two views of battery of generator units totalling 1200 H.P. and building in which this auxiliary plant is located.

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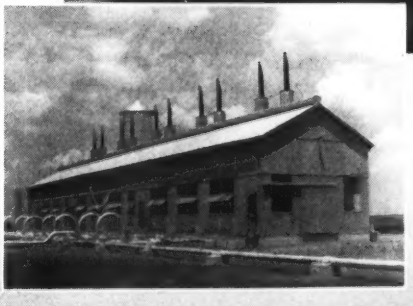

Photographs show front and rear view of the battery of 5 CLARK 800 H.P. "Angles" in main plant, and building in which it is housed.

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Distillate Recovery—An Engineering View of "Retrograde Condensation"

C.N.G.A. 1940 FALL MEETING

By Henry N. Wade
Parkhill-Wade, Inc.

Since most of the engineering of distillate recovery plants and systems revolves around the so-called "retrograde condensation" phenomena, we will describe these phenomena briefly, to show how they affect such engineering.

Retrograde Condensation

At ordinary temperatures, and pressures ranging from atmospheric to perhap four or five hundred pounds per square inch, it is well known that increasing pressure increases the tendency of a gas-vapor mixture to condense. This fact was used in the earliest "compression" type gasoline plants for the extraction of gasoline from natural gas. It was quite common in such plants to compress gas taken from wells or traps at low pressures, or even through vacuum, up to pressures ranging from two hundred to three hundred pounds per square inch.

The heat of compression was removed from the compressed gas by passing it through cooling coils or sections. The partially condensed mixture was then passed into a separator where the gasoline was dropped out of the stream, and passed on for stabilization by various methods. This scheme of operation gave reasonably good extraction efficiencies with those gases which permitted a fairly high percentage of condensation.

In accordance with well-known laws of physics, the condensation of gasoline in the process just described could be increased by lowering the separation temperature below temperatures attainable by cooling coils in spray towers. This fact was recognized and employed in some of the earliest plants. Various schemes for producing this additional cooling were used, such as ordinary refrigeration cycles and "expander" engines.

On a laboratory experimental basis it has been known for over sixty years that if the pressure of a mixture of a gas and a liquid vapor is increased, the increase of condensation of liquid out of the mixture stops at some definite pressure. Further increase in pressure beyond this so-called "critical" pressure results not in further condensation, but in an actual re-evaporation of the liquid already condensed, until finally all of the liquid has gone back to the vapor phase. It is understood of course that throughout these changes in pressure the temperature on the system is held constant.

Over ten years ago it was realized that these phenomena occur in connection with mixtures of hydrocarbon vapors, such as are encountered in natural gas or oil wells. We had direct experience with those phenomena in connection with one gasoline plant which was built in northwestern Louisiana in 1930. The wells

Henry N. Wade

supplying this plant produced at a well head pressure around 1,750 pounds per square inch. Since the residual gas from the plant was to be delivered into a pipe line at a pressure not over 300 pounds per square inch, the pressure on the wet gas was cut by regulators at the well head to avoid expensive high pressure piping into the plant.

The wet gas passed through an inlet scrubber before entering the absorbers. As soon as the plant was put into operation it was observed that this scrubber accumulated large quantities of a water-white distillate having most of the characteristics of a good grade of motor gasoline. The end point was approximately 425 degrees, and with a little weathering this drip gasoline did actually make a very satisfactory motor fuel. We were interested in this phenomenon and investigated conditions up-stream of the regulator. We found that no traces of liquid appeared in the gas ahead of reduction in pressure, although about .3 gallon per thousand of this water-white distillate accumulated in the inlet scrubber. This was a clear-cut instance of retrograde condensation since the temperature of the high pressure gas ahead of the well regulators was approximately the same as that of the expanded gas at its entrance into the inlet scrubber.

This phenomenon was encountered in the research work conducted on oil and gas mixtures at California Institute of Technology under the direction of Dr. W. G. Lacey, and was referred to by him in his report published by the American Petroleum Institute, Bulletin No. 210 in 1932.

We have prepared Fig. 1 to show in a general way two or three of the outstanding characteristics of the retrograde phenomena. This chart is a plot on log-log paper showing the values of the K factors for propane and average heptanes at a temperature of 80 degrees F. In considering this chart it should be remembered that the K factors are simply proportional to the tendency of the liquid phase to vaporize under the specific conditions of temperature and pressure. For example, the propane curve shows a K factor of 1.0 at a pressure of 148 pounds absolute, and a factor of 0.5 at a pressure of 340 pounds absolute. This means that the tendency of the propane to vaporize or evaporate is twice as great under the first pressure as under the second.

Following down the propane curve from the upper left-hand corner of the chart it is apparent that the K factor, or evaporating tendency, decreases with increasing pressure down to a value of about 0.285 at a pressure of about 1,100 pounds per square inch absolute. Over this part of the chart the behavior of the propane is in the so-called "normal" range, since the evaporating tendency decreases steadily with increasing pressure; or putting it another way, the condensing tendency increases steadily with increasing pressure.

As the pressure on the mixture of gas and propane vapor is increased beyond the so-called "critical" pressure of 1,100 pounds, it is seen that the value of the K factor begins to increase, and continues increasing up to a value of 0.5 at the pressure of 3,000 pounds per square inch, which is the end of the chart.

The propane curve shows two different pressures at which the K factor has a value of 0.5; namely, 3,000 pounds and 340 pounds. This means that the tendency of propane to condense out of a gaseous mixture is the same at a temperature of 80 degrees F. for either of these pressures.

It should be noticed that if the pressure on the gas-vapor mixture is decreased from the chart limit of 3,000 pounds to any lower pressure down to about 1,100 pounds, the K value de-

creases with decreasing pressure, which means that the tendency to condense propane out of the mixture increases with decreasing pressure. This explains the phenomenon we observed at the gasoline plant mentioned above, and also accounts for the wide-spread early practice of producing so-called distillate wells by dropping the pressure on the gas mixture at the well head to some lower pressure, usually in the range from 1,000 pounds down to about 300 pounds, and then passing the expanded mixture into a separator for recovery of the distillate.

Referring to our curve for heptanes in Fig. 1, it is seen that the nature of the phenomena is exactly the same as that for propane, except that the so-called "critical" point occurs at a pressure of about 500 pounds per square inch instead of 1,100 pounds for propane. This is a characteristic of the behavior of these materials; namely, that the critical pressure declines with increasing molecular weight of the hydrocarbons.

Particular attention should be called to one other characteristic of the "retrograde range"; namely, that the degree of condensation at a given pressure increases with decreasing temperature, in exactly the same way that decreasing temperature increases condensation within the so-called "normal" range of pressure.

Definition of a Distillate Structure

During the past six or eight years many areas have been discovered, particularly in the South Texas and Gulf Coast districts, in which the hydrocarbons are entirely in vapor phase in the formation, but will partially condense upon reduction in pressure or temperature or both. These wells were originally produced by expanding the gas through a choke to some moderate pressure, and then passing the partially condensed mixture into an ordinary gas-oil separator The residual gas after this separation was either used for fuel or wasted. The operating pressure in the trap varied commonly between a minimum of about 300 pounds per square inch up to a maximum of perhaps 600 pounds per square inch. The operators arrived at the best separator pressure by cut-and-try methods. If the trap pressure were carried too high the separated distillate would contain an excessive amount of light fractions and dissolved gases, and would consequently show excessive weathering losses when run into the field storage tanks. Also, the gas would undergo less Joule-Thomson cooling in expanding through the choke, so that the trap temperature would run higher and there would be less initial condensation.

On the other hand, if the trap pressure were carried too low, the normal decrease in condensation due to lowering pressure would become the dominant factor, and only a small amount of material would actually condense. Operators found that by juggling the trap pressure an operating pressure could be selected which produced the maximum amount of salable distillate in the field tanks.

Producing structures of this type, where the hydrocarbon mixture is entirely in vapor phase in the formation, but is of such a nature that condensation may be produced by reduction of pressure and temperature into normal ranges, have come to be called "distillate" structures.

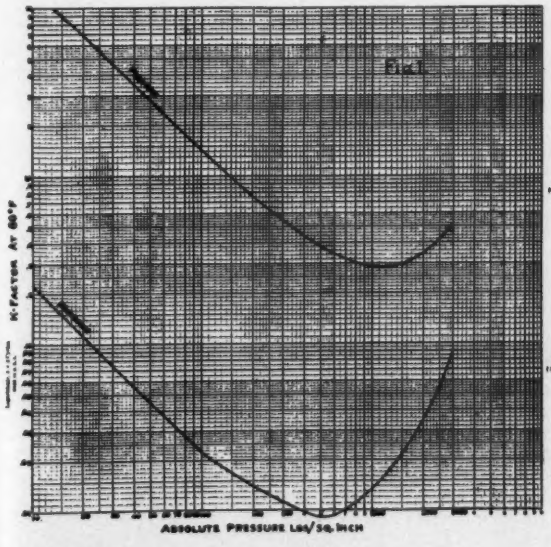
It should be borne in mind that the retrograde condensation phenomena just described also occur in connection with the vapor phase of two-phase structures, where liquid and vapor phases both occur in the producing formation. The distinction here is that liquids can be produced from two-phase structures by simple pressure displacement or pumping, without necessarily involving the operation of the retrograde condensation phenomena, whereas production from a distillate well necessarily involves retrograde condensation.

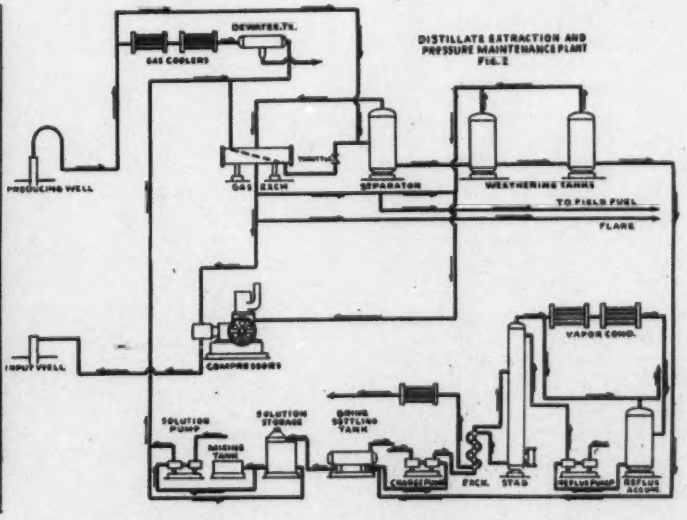
Recovery Systems

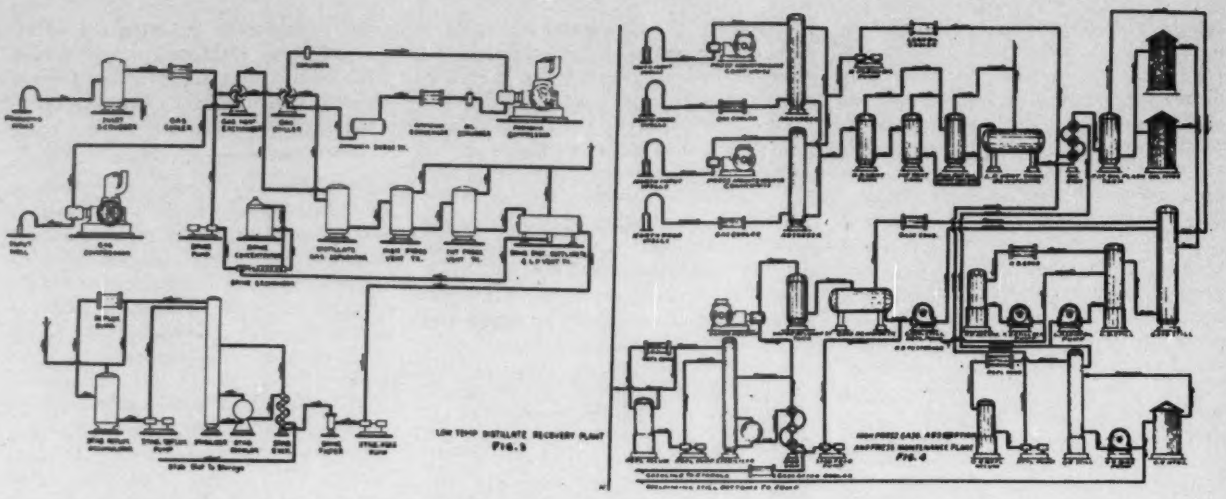
Since, due to retrograde condensation, a distillate type gas in its formation may partially condense if the pressure on the formation is reduced, without reduction in temperature, it is essential that the pressure in the formation be maintained as high as possible throughout the period of production If condensation does occur in the formation due to reduction of pressure, the diffused condensate will simply moisten the porous producing sands, and the hydrocarbons so condensed will become irrecoverable In many of the early developments of distillate production this fact was disregarded and serious declines of recoverable distillate content were actually experienced in the course of time as gas was withdrawn from the formations, causing pressuch decline.

This fact makes it imperative to provide some scheme for maintaining the pressure in the producing formation at or near its original value.

It is imaginable that some distillate structures may be found which have a water-drive sufficiently active to maintain the pressure in the formation while withdrawing gas at a reasonable rate; however, no such formations have actually been encountered so far in the development of these properties. The only practical way of maintaining the formation pressure is to inject into the producing formation the residual gas after the distillate has been recovered from it. Ordinarily the shrinkage due to extraction of distillate plus fuel requirements for the operation of the extraction and pressure maintenance plants does not amount to more than four or five per cent of the volume of wet gas withdrawn; consequently, if all the residual gas is returned to the formation the rate of pressure decline is







greatly reduced, or may be eliminated entirely if the rate of water-drive is rapid enough to make up the difference.

On account of these facts it is now generally recognized that a pressure maintenance system is a necessary part of any efficient distillate recovery project, and all of the recent installations have included such a system.

Well Patterns

Since an effective distillate recovery system requires withdrawing the wet distillate gas from the formation and replacing it eventually with the residual gas remaining after the distillate has been extracted, it is evident that the producing and input wells must be located so as to accomplish this result with the least chance of dilution of the wet gas by the dry gas returned to the formation. The ideal arrangement of wells to accomplish this purpose is still a matter of some experimentation and a great deal of discussion. The following discussion is intended to bring out some of the points which have been learned by experience with several of the largest distillate recovery systems. It is not intended that these plans are necessarily the correct ones in all cases, since individual structure conditions may have a determining bearing on planning a well pattern.

If a structure is of round or oval shape and is all under one ownership so that adverse property lines have no bearing on the design of the well pattern, it now seems pretty well established that the producing wells should be drilled around the rim of the structure and the input wells should be placed near its center. The principal reason for this arrangement lies in the fact that it is usually possible to handle more gas through an input well of a given physical size than through a producing well of the same size. Also, in most of the Gulf Coast structures so far discovered it has been found that the sands are often thicker and more permeable near the center of the structure than around the edge; consequently, an input well located near the center can handle more gas than if it were located toward the outside.

Another reason for this arrangement is that it affords more flexible control of the displacement of the wet gas by dry gas. It is possible for the dry gas to tend to channel toward a producing well in case the producing formation contains crevasses, or has within it a relatively thin layer of highly permeable material. If such "channeling" begins to show up with a well pattern as described, it may be at least partially controlled by reducing the rate of take from the well or wells which first show the beginning of dilution. In this way the rate of spread of the dry gas in the formation can be regulated so as to favor a uniform sweeping out of the wet gas in the structure.

If the well pattern were reversed, that is, producing wells toward the center and input wells around the flanks, it is obvious that such channeling will be much more likely to affect all of the producing wells, since the flow of dry gas through the formation is inward along converging lines instead of outward along diverging lines.

In the case of a long narrow structure it is possible to work out well patterns which may be more effective than the simple radial scheme just described. If the long axis of the producing structure is say six or eight times the width, the area can be divided into several sections by parallel transverse rows of producing wells and input wells. In this way several zones of low pressure are established across the structure by rows of producing wells, and in between these low pressure zones high pressure zones are produced by rows of input wells. By using suitable spacing and control of production and input rates at the various wells it is evident that the advance of the dry gas can be made practically a straight line, so that the wet gas is swept out uniformly and completely.

In case the structure is under several adverse ownerships, the well pattern must of course be worked out so as to prevent, as far as possible, either dilution or drainage across property lines. It is obvious that such considerations will require a careful study of each individual case, and that no general rules for development can be laid down. Often it can be arranged between the adverse ownerships to set up a row of input wells along each side of the dividing property line; such an arrangement would seem to give each owner a maximum of protection against interference from the other.

Producing Wells

It has been general practice in the Gulf Coast to complete producing wells by gun perforation. It is obvious that enough holes should be shot to permit the well to produce at the required rate without excessive pressure drop between formation pressure and pressure in the well.

The wells are ordinarily produced through tubing, since it is necessary to keep up the velocity of a production stream so as to carry along condensed liquid. Attempts to obtain distillate production from the casing have not usually succeeded, since the velocity in the casing is too slow to carry along the distillate condensed by cooling and pressure reduction within the casing. The distillate therefore accumulates in the well, causing it to flow by violent heads, or in some cases to stop production altogether.

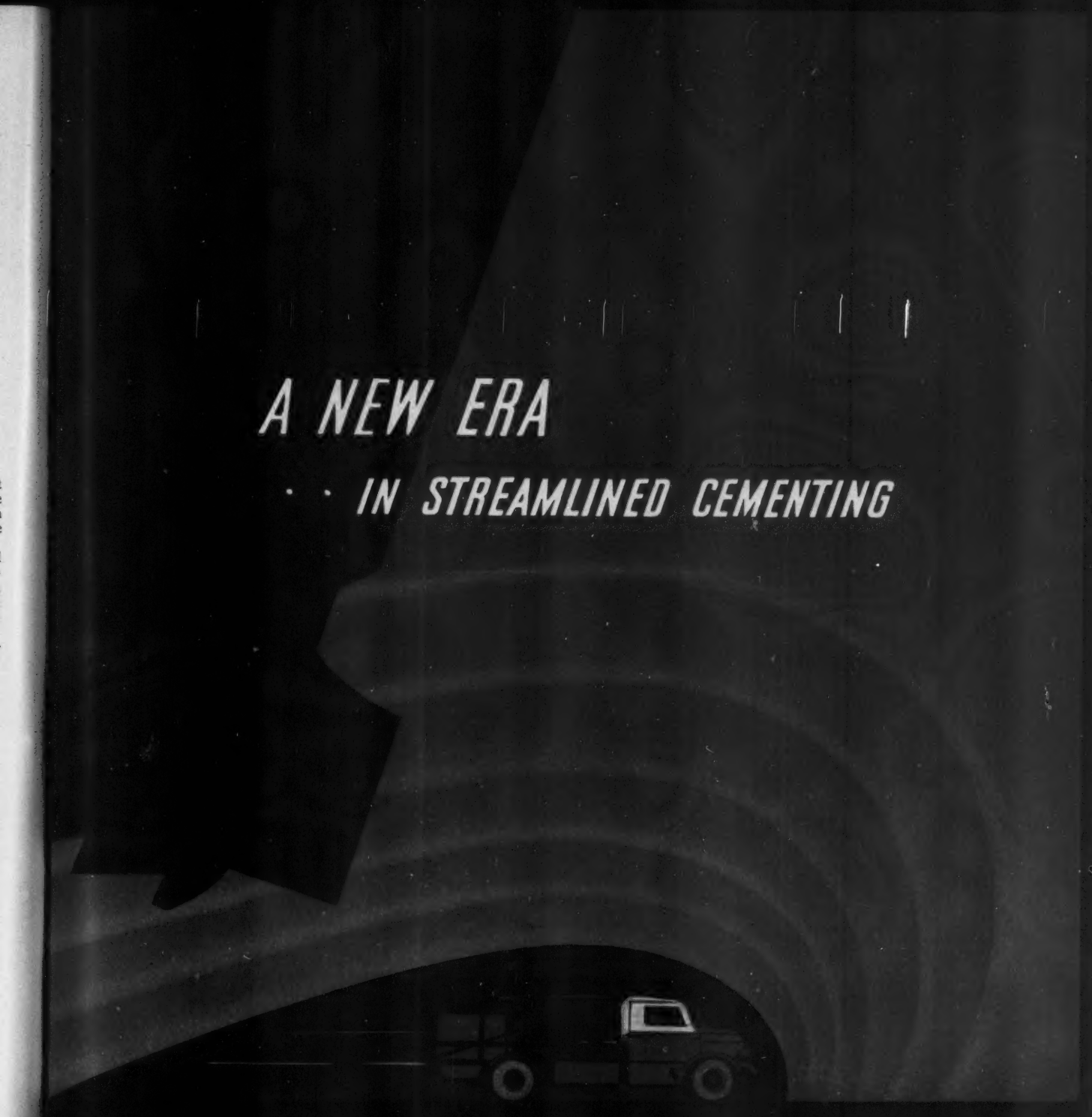
One interesting method of completing producing wells into two separate producing sands is being practiced by one of the large operators near Corpus Christi, Tex. This operator completes his wells into a lower sand and runs a tube carrying a packer at its lower end to take production from the sand. The well is also shot out into some higher producing sand, and production is taken from this sand through the annular space between the tubing and a larger pipe which is run down in the well surrounding the tubing. The sizes of the tubing and outer tubing are, of course, selected so as to give the required velocity when under production at normal rates. This scheme enables the operator to take production from two separate sands through only a single well, without any mingling or mutual interference.

Input Wells

Since the sole purpose of an input well is to return as much gas as possible to the producing formation at a minimum of pressure drop between the inside of the input well casing and the formation, everything should be done in the completion of such a well to further these ends. It has generally been found that it is worthwhile to set a screen section in the producing horizon in order to expose as much formation surface as possible. In some instances operators claim better results using gun completions with as many as three hundred shots.

Processing Plants

(a) **Simple Separation.** The earliest distillate producing plants were installations of standard oil-field type separators which were connected up to the



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producing wells through chokes at the well heads. With some heavy types of distillate such an installation can show extraction efficiencies as high as 80 per cent of the usable materials in the wet gas. The addition of the pressure maintenance compressors completes a distillate recovery system; several such installations have been made.

A desirable but not essential addition to such a system consists of a stabilizer for the purpose of removing the undesirable propane and lighter fractions from the distillate.

In order to improve the efficiency of a simple system of this type it is, of course, often desirable to cool the incoming gas before separation. Sometimes the natural cooling due to the expansion in the choke is enough to give fair efficiency. In some cases this cooling has been enhanced by the use of cooling coils under water spray or submerged in ponds or streams.

(b) **Simple Separation with Regenerative Cooling.** In plants of this type a heat exchanger is placed in the wet gas stream following the spray coil cooling, and some expansion occurs in a throttle valve in the wet gas down-stream from this exchanger. The expanded mixture then passes to the separator, and the residual gas passes back through the other side of the heat exchanger and on into the suction of the pressure maintenance compressors. This scheme makes use of the well-known principle of regenerative refrigeration, which has been used for many years in connection with the liquefaction of air and other gases.

Fig. 2 shows a simplified flow diagram of such a plant. The gas passes through atmospheric spray tower cooling coils and a water separator into the heat exchanger and thence to the main separator. The residual gas returns from the separator through the exchanger to the pressure maintenance compressors.

In this particular plant a temperature of about 25°F. is maintained in the separator. Since this temperature is far below the hydrate formation temperatures at the separator pressure of 1,250 pounds per square inch, it is necessary to prevent freezing in the gas passages. This is done by injecting a concentrated solution of calcium chloride into the wet gas stream just ahead of the heat exchanger. This solution mingles with the gas and absorbs sufficient water so as to prevent any trouble from freezing or hydrate formation. The partially diluted solution goes out of the separator along with the distillate through the distillate weathering stages into a large gravity settling tank. From this tank the distillate is withdrawn for charging to the stabilizer, and the separated brine is withdrawn, reconcentrated by evaporation and returned to the system.

At this particular plant the pressure of the gas up to the throttle ahead of the separator is about 1,700 pounds, and the separator is carried at a pressure of 1,250 pounds with a temperature of about 25°F. Under these operating conditions the plant shows an extraction efficiency of approximately 92 per cent of the pentanes and heavier available in the wet gas.

(c) **Simple Separation with Refrigerative and Regenerative Cooling.** Plants of this nature are used where the refrigeration afforded by expansion of the high pressure gas is not enough to give a satisfactory extraction efficiency. The flow sheet in general is the same as that for the type of plant just described, except that a refrigeration cycle of some sort is added to produce further cooling of the wet gas after it has passed through the regenerative gas-to-gas exchanger.

In plants of this type it is of course necessary to use some method for preventing freezing or hydrate formation in the colder parts of the system. This is ordinarily done by injecting calcium chloride brine or diethylene glycol solutions into the incoming wet gas stream, as described above.

Fig. 3 shows the flow sheet of such a plant recently built in East Texas. In this plant the separator temperature is maintained at about 0°F. and the pressure at around 1,200 pounds. Under these conditions the plant shows an extraction efficiency of better than 90 per cent when processing a gas having a comparatively light gasoline content.

(d) **Absorption Plants.** Theory as well as experience has shown that, with plants of the preceding types, it is practically impossible to attain extraction efficiencies much better than 90 per cent. Plants of these types find many applications however, since they are comparatively simple and cheap when applied to relatively small operations.

One of the most serious limitations of these simple plants is the fact that they require expanding the wet gas down to a pressure not much in excess of 1,200 pounds per square inch in order to achieve even the comparatively low efficiencies mentioned. If the final separation is carried out at pressures much higher than this, the retrograde phenomena reduce the amount of condensation, and in order to regain the efficiency so lost it is necessary to go to still lower separator temperatures. This is obviously a serious handicap to plants of this type, since the pressure of delivery of the separated dry gas to the suction of the pressure maintenance compressors directly effects the compressor horsepower required.

Several absorption plants have been built and are now in operation at pressures ranging from 1,500 to 1,800 pounds per square inch. It has been found that the actual performance of these plants agrees well with the calculated performance, and that it is perfectly feasible to build such plants to give an extraction efficiency for pentanes and heavier in excess of 98 per cent.

Up to the present time it seems probable that absorption oil losses due to retrograde evaporation in the absorbers will become excessive at some pressure around 2,500 pounds per square inch, but we now feel confident that it is feasible to build such plants for pressures at least as high as 2,000 pounds per square inch. On large projects these efficient absorption plants cost no more, and often actually cost less, than any of the other types of plants just described, considering the extraction unit alone. In addition they will frequently show tremendous savings in pressure maintenance compressor horsepower on account of the higher suction pressure attainable. Thus in general it may be said that on large projects absorption type plants will show not only a substantial saving in investment but will produce at least 10 per cent more gasoline as compared with plants of any of the other types.

Fig. 4 shows a typical flow sheet of a large high pressure absorption plant recently placed in operation in south Texas. In this case the wet gas sources are in two districts at somewhat different pressures. The absorbers and the pressure maintenance compressors were divided into two groups so as to permit treating and returning of the gas under two separate pressures.

In absorption plants operating at these extreme pressures the amount of fixed gases dissolved in the absorption oil is, of course, tremendous; consequently it is necessary to provide special means for handling these gases. One of the most effective schemes, shown on the flow sheet, is to pass the fat oil through several stages of weathering at carefully calculated pressures. By a suitable selection of these weathering pressures a fairly sharp segregation of the fixed gases can be made, so as to permit reasonably normal conditions in the distillation system. Sometimes we have found it necessary to employ an auxiliary absorber to reprocess the vapors leaving the low pressure fat oil vent tank in order to preserve enough butanes in cases where the wet gas is deficient in these fractions.

The characteristic Gulf Coast distillates contain fractions with boiling points up as high as 500° to 600°F. On account of this it is usually necessary to arrange the plant to produce at least two products; one, a controlled end point motor gasoline or naphtha, and two, a specification kerosene or kerosene distillate. In the plant shown this is accomplished by passing the fat oil after weathering through a primary or gasoline still operating at about 50 pounds pressure and then passing the lean oil stream containing the absorbed heavy fractions through a low pressure still for removal of the materials boiling above the desired end point of the gasoline cut.

The Patent Situation

Early this year a patent pool was formed under the name of Distillate Engineering & Processes Company with headquarters at Tulsa, Oklahoma. Up to the present time this company has pooled distillate process patents held by Stanolind Oil and Gas Company, Seaboard Oil Company of Delaware, Eureka Process Corporation and Tide Water Associated Oil Company. We understand also that the Standard Oil Development Company is a participating member on the basis of certain research work which has not yet resulted in the issuance of patents.

The patents so far disclosed as belonging to the Distillate Engineering & Processes Company are as follows:

Assigned to:	Issued to:	Number	Date
Tide Water Associated	William H. Vaughan	2,133,774	10-18-38
and Seaboard Oil	William H. Vaughan	2,151,248	3-21-39
Companies	William H. Vaughan	2,198,098	4-23-40
Stanolind Oil and	George S. Bays	2,135,319	11-1-38
Gas Company	George S. Bays	2,156,234	4-25-39
Eureka Process	J. P. Walker and)	2,080,351	5-11-37
Corporation	E. V. Foran)	2,174,336	9-26-39

All of the patents in the above list apply to operations of the first three types described above, and do not specifically bear on absorption type plants, although some of them have claims broad enough to possibly cover such plants.

A total of about 20 distillate recovery plants are now in operation, producing something like 20,000 barrels per day of distillate. Of these plants at least 8 are licensed under the DEPCO patents on account of the fact that the operating companies are participants in the DEPCO group. To the writer's present knowledge only one company outside this group has taken a license.

Among the other plants, representing a daily production of about 14,000 barrels, are representatives of all the types described in this paper, including five or six high pressure absorption units. Among these unlicensed plants are operations which might be held to infringe some or all of the claims in the above list of patents.

This confused patent picture has persisted for a period of several years, and it is to be hoped that it can be cleared up in the near future by discussion and agreement between the interested parties.

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Production « « » » Development

(Figures of Production and Stocks are in barrels of 42 Gals.)

	Total Production September	—DAILY AVERAGE— Sept., 1940	Aug., 1940	Sept., 1939
Group No. 1				
Arvin	43,835	1,461	1,445	2,163
Belridge—North	300,889	10,030	10,683	11,816
Belridge—South	64,297	2,143	2,045	1,134
Canal	157,876	5,263	5,531	5,659
Canfield Ranch	955	32	34	80
Coalinga	857,865	28,596	28,186	20,486
Cole's Levee	103,262	3,442	3,984	1,739
Edison	69,239	2,308	2,222	2,133
Elk Hills	363,200	12,107	12,043	10,350
Fruitvale	171,789	5,726	5,681	6,304
Greeley	136,406	4,547	4,659	2,298
Kern River	335,914	10,864	11,209	11,958
Kettleman Middle Dome	.....	.....	.....	.....
Kettleman North Dome	1,408,950	46,965	46,786	52,263
Lost Hills	111,374	3,712	3,664	3,572
McKittrick	107,597	3,586	3,880	3,707
Midway-Sunset	1,462,732	48,758	49,662	49,039
Mountain View	189,160	6,305	6,393	7,915
Mount Poso	280,338	9,345	9,197	10,976
Paloma	14,605	487	498	166
Rio Bravo	293,642	9,788	9,122	7,659
Round Mountain	215,041	7,168	7,429	8,509
Strand	44,115	1,471	1,602	657
Ten Section	304,004	10,133	9,813	9,048
Tupman	166,223	5,541	3,669	583
Wasco	55,494	1,849	1,444	1,526
Wheeler Ridge	9,146	305	312	330
Group No. 2				
Capitan	48,870	1,629	1,721	2,230
Elwood	97,995	3,267	3,414	4,120
Rincon	150,008	5,000	4,680	3,487
San Miguelito	95,351	3,178	3,243	2,872
Santa Barbara	6,310	210	235	274
Santa Maria	173,743	5,791	9,787	4,667
Santa Maria Valley	587,710	19,590	18,445	13,935
Summerland	757	25	30	22
Ventura Avenue	993,538	33,118	34,635	34,957
Ventura-Newhall	239,595	7,987	8,096	6,877
Watsonville	750	25	25	30
Group No. 3				
Brea-Olinda	165,802	5,527	5,816	5,722
Coyote—East	111,702	3,723	3,877	2,626
Coyote—West	206,742	6,891	7,980	9,311
Domingues	651,687	21,723	22,207	18,150
El Segundo	54,228	1,808	2,031	2,912
Huntington Beach	789,967	26,332	25,378	26,229
Inglewood	341,526	11,384	11,560	12,427
Lawndale	1,478	49	34	33
Long Beach	1,304,775	43,493	43,153	44,976
Los Angeles-Salt Lake	16,612	554	519	541
Montebello	508,603	16,954	17,490	25,726
Playa Del Rey	121,948	4,065	4,073	4,680
Potrero	64,052	2,135	1,904	1,214
Richfield	271,135	9,038	9,214	8,723
Rosecrans	390,247	13,008	12,952	10,409
Santa Fe Springs	758,546	25,285	26,098	27,020
Seal Beach	193,712	6,457	6,794	7,105
Torrance	298,368	9,942	10,502	15,079
Whittier	5,992	200	199	895
Wilmington	2,468,406	82,280	83,893	86,084
Total	18,378,003	612,600	621,178	615,431
August	19,256,524	621,178		
Decrease	878,521	8,578		

	New Rigs Up	Active Drilling	Producers Completed	Daily Initial Output	Active Producing	Abandoned Wells Drillers	Abandoned Wells Producers
Group No. 1							
Arvin	..	....	....	....	16	....	....
Belridge—North	1	2	....	....	60	....	....
Belridge—South	..	....	....	....	188	....	....
Canal	..	1	....	....	34	....	....
Canfield Ranch	..	....	....	....	1	....	....
Coalinga	11	25	4	5,429	865	1	....
Cole's Levee	4	7	2	1,717	27	....	....
Edison	..	....	....	....	97	....	....
Elk Hills	..	....	....	....	194	....	....
Fruitvale	..	....	....	....	170	....	....
Greeley	4	4	....	....	34	....	....
Kern River	..	1	1	72	1,555	....	....
Kettleman North Dome	2	8	1	314	267	1	....
Lost Hills	..	....	....	....	273	....	....
McKittrick	..	....	....	....	203	....	....
Midway-Sunset	2	5	4	1,004	2,531	....	....
Mountain View	..	....	....	....	182	1	....
Mount Poso	2	3	....	....	286	1	....
Paloma	..	2	....	....	3	....	....
Rio Bravo	1	7	4	6,198	63	....	....
Round Mountain	2	1	2	515	225	1	....
Strand	..	1	....	....	8	....	....
Ten Section	5	4	3	6,291	58	....	....
Tupman	7	12	5	6,564	27	....	....
Wasco	..	1	....	....	12	....	....
Wheeler Ridge	..	1	....	....	34	....	....
Group No. 2							
Capitan	..	....	....	....	41	....	....
Elwood	..	....	....	....	74	....	....
Rincon	2	1	1	676	65	....	....
San Miguelito	..	3	1	793	24	....	....
Santa Barbara	..	....	....	....	19	....	....
Santa Maria	..	....	1	385	180	....	....
Santa Maria Valley	1	1	1	565	141	2	....
Summerland	..	....	....	....	8	....	1
Ventura Avenue	4	9	2	515	327	....	....
Ventura-Newhall	8	10	....	....	534	....	....
Watsonville	..	....	....	....	7	....	....
Group No. 3							
Brea-Olinda	1	1	....	....	356	....	....
Coyote—East	2	5	1	70	85	....	....
Coyote—West	..	....	....	....	62	....	....
Domingues	1	2	5	2,711	188	....	....
El Segundo	..	....	....	....	43	....	....
Huntington Beach	3	3	4	1,924	534	....	3
Inglewood	1	....	1	360	192	....	....
Lawndale	..	....	....	....	5	....	1
Long Beach	1	5	1	87	1,222	....	1
Los Angeles-Salt Lake	..	....	....	....	103	....	....
Montebello	..	1	....	....	324	....	....
Playa Del Rey	..	....	....	....	156	....	....
Potrero	..	....	....	....	19	....	....
Richfield	1	1	1	150	305	....	....
Rosecrans	2	5	2	585	164	....	....
Santa Fe Springs	..	....	....	....	591	....	1
Seal Beach	..	1	....	....	120	....	....
Torrance	..	....	....	....	644	....	5
Whittier	..	....	....	....	38	....	....
Wilmington	13	9	14	4,457	880	....	....
Miscellaneous Drilling	8	28	....	....	....	6	....
Group No. 4—Gas Fields							
Buena Vista Lake	..	....	....	....	....	....	....
Buttonwillow	..	....	....	....	16	....	....
Chowchilla	..	....	....	....	....	....	....
Delano	..	....	....	....	14	....	....
Fairfield Knolls	..	....	....	....	....	....	....
Goleta	..	....	....	....	....	....	....
Marysville Buttes	..	....	....	....	3	....	....
McDonald Island	..	....	....	....	5	....	....
Rio Vista	1	1	1	Gas	21	....	....
Semi-Tropic	..	....	....	....	....	....	....
Tracy	..	....	....	....	1	....	....
September	90	171	62	41,382	14,933	13	12
August	81	176	73	57,423	14,931	8	18
Decrease (*Increase)	9*	5	11	16,041	2*	5*	6

SUMMARY OF CALIFORNIA OILFIELD OPERATIONS FOR SEPTEMBER, 1940—STOCKS HELD IN PACIFIC COAST TERRITORY BY CALIFORNIA OIL COMPANIES

	Sept. 30, 1940	Aug. 31, 1940	Sept. Changes	Sept. 30, 1939
1. Gasoline-Bearing Crude	35,367,172	36,360,453	− 993,281	37,115,203
2. Non-Gasoline-Bearing Crude	12,584,562	12,818,762	− 234,200	14,074,602
3. Unblended Nat. Gas	2,752,640	2,765,839	− 13,199	2,049,211
4. Gasoline (not including distributing and service stations)	14,532,495	14,458,803	+ 73,692	13,454,290
5. Naphtha Distillates	1,865,261[1]	1,960,407[1]	− 95,146	1,487,704[1]
6. Gas Oil and Diesel Oil	10,622,136	10,112,598	− 509,538	9,979,845
7. Fuel Oil Residuum	62,840,120	63,600,163	− 760,043	68,850,703
8. All Other Stocks	8,731,693[2]	8,804,958[2]	− 73,265	7,647,251[2]
TOTAL	149,296,079	150,881,983	−1,585,904	154,658,809
[1]Estimated amount of unfinished gasoline in item 5	1,693,753	1,732,886		1,176,350
[2]Coke included in item 8	1,103,750	1,167,955		597,023

Application of Mass Spectrometry

to Analysis of HC Gas Mixtures

C. N. G. A. 1940 FALL MEETING

By H. Washburn, D. D. Taylor, E. E. Hoskins, and R. V. Langmuir [1]

With the improvement in techniques of obtaining high quality gasoline and other fuels from petroleum, the analysis of hydrocarbon gas mixtures has become of increasing commercial importance. Some of the methods of analysis used today are fairly rapid and simple, while other important analyses take considerable time and are relatively expensive. Consequently, a new, rapid and accurate method of analyses should be welcome. The application of the mass spectrometer provides such a method.

For some time our laboratory has been analyzing hydrocarbon gas samples, and a general report on the results was given in a paper[2] by Herbert Hoover, Jr., and the senior author.

The present paper is devoted to a discussion of analyses of particular interest to laboratory men and to refinery and natural gasoline plant operators.

Before discussing these applications, a brief description of a mass spectrometer may be in order. A spectrometer is shown diagrammatically in Figure 1. It consists of the ionization chamber **a**, the analyzer tube **b**, the collector **c**, and the amplifier **d**. The ionization chamber, analyzer tube and collector and enclosed in an air-tight container, which is kept under a high vacuum. This container is placed in a uniform magnetic field, preferably supplied by a large electromagnet. The gas to be analyzed is introduced into the ionization chamber through a capillary leak or gas inlet.

In the ionization chamber, the gases are bombarded by low-voltage electrons emitted by a filament. This bombardment ionizes the molecules and thereby they become positive ions. As a result of their positive charge the ions are accelerated toward the slit **e**, which is kept at a small negative potential with respect to the rest of the ionization chamber. After passing through **e**, the ions are further accelerated toward slit **f**, which is kept at a large negative potential with respect to slit **e**. This potential is usually of the order of a thousand or more volts. The ions thus pass through slit **f** at a high velocity. The path they take is curved, owing to the action of the magnetic field. The radius of curvature of the path for a given accelerating voltage depends upon the ratio of the charge on the ion to its mass or atomic weight. Hence, the ions of a given mass or atomic weight will follow one curved path while those of a heavier mass or atomic weight will follow another curved path of greater radius. By proper adjustment of the magnetic field or of the accelerating voltage, or of both, ions of any desired mass can be made to follow a predetermined radius of curvature and thus to pass through an exit slit **g**. Only the ions passing through this slit can strike the collector **c**, where their quantity is measured by a suitable vacuum-tube amplifier and galvanometer or recorder.

Thus the quantity of ions present of any particular mass can be measured by properly adjusting the magnetic or electric fields of the spectrometer and measuring the deflection on the galvanometer. Experiment shows that if a single pure gas is introduced into the mass-spectrometer, ions of several different masses will appear. This is illustrated by Fig. 2 which shows the ions produced when normal butane is introduced into the mass spectrometer. The abscissa show the atomic weights, together with the chemical formulae of the ions measured. The ordinates show the relative number of each of these ions produced. The relative amounts of ions appearing at the different masses constitute an ionization pattern or mass spectrum. The pattern of the mass spectrum is different for different gases and thus furnishes a means of recognizing the presence of any given gas. The magnitude of the peaks in the mass spectrum is a measure of the quality of the gas.

If a mixture of gases is introduced into the spectrometer, a mass spectrum will appear which is a composite or superposition of the mass spectra of the separate gases. The quantitative and qualitative analysis of the gas mixture can be determined from this composite mass spectrum. The method of making the determination is outlined in the following examples.

Figure 3 shows the mass spectrum which would be obtained for a liquid propane fuel, composed of 4.5% ethane, 95% propane, and 0.5% iso-butane. The composite spectrum is given by the column on the extreme right hand side, and is the result which would be given by the mass spectrometer for the mixture. The contribution to this composite spectrum of each of the gases of the mixture is shown in the other columns. These columns are part of the computations involved in the analysis.

Only four properly chosen peaks of the composite spectrum are necessary for the analysis of a mixture containing a possible four gases. The remaining peaks serve as a check on the accuracy of the results. The example which follows will clarify these statements.

Assume that the only known data are those given by the mass spectrometer—in other words, the column labelled "Total Peak." First the fact that no normal butane is present is determined by the ratio of the 57 to 58 peaks, since this ratio is different for normal and iso-

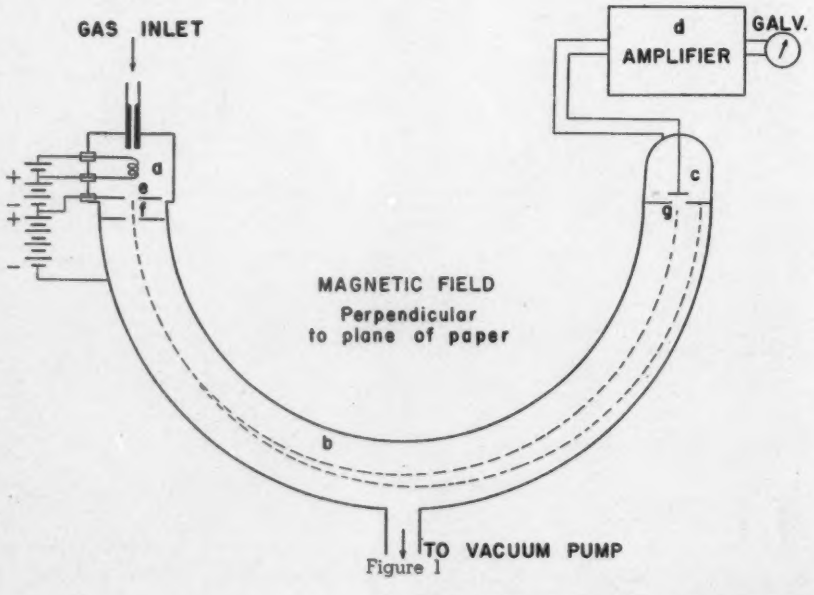

Figure 1

[1] *Research Department, United Geophysical Co., Pasadena, Calif.*

[2] *"A Preliminary Report on the Application of the Mass Spectrometer to Problems in the Petroleum Industry." AIMME Technical Publication No. 1205. May, 1940.*

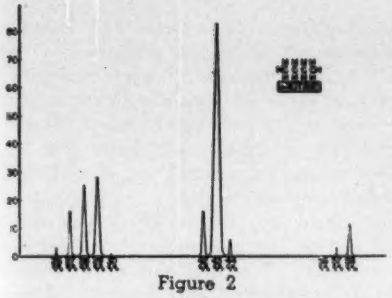

Figure 2

butanes. Therefore, iso-butane is the only gas of the mixture which contributes to the peak at mass 58. The amount of iso-butane can be computed directly from peak 58 as shown by equation (1). The value 0.505 in this equation is the iso-butane sensitivity factor of the spectrometer, determined by calibrating the instrument with a known quantity of pure iso-butane. The value 1.0 comes from the composite spectrum. Performing the indicated multiplication gives 0.5% as the iso-butane content of the mixture. Now that the quantity of iso-butane in the mixture is determined, its contribution to the peaks at all masses can be written down from the mass spectrum obtained in the iso-butane calibration.

The amount of propane present can next be determined from the 43 peak as shown in equation (2). The part of the 43 peak which is contributed by propane is obtained by subtracting the contribution of the iso-butane to this peak from the total peak. The value .112 in this equation is the propane sensitivity factor of the spectrometer. Performing the indicated multiplication gives 95% as the propane content of the mixture. The contribution of propane at various masses is then written down from the mass spectrum obtained in the propane calibration.

The amount of ethane in the mixture is then computed from peak 30 in a similar manner by subtracting the contributions of propane and iso-butane from this peak to determine the part of peak 30 which is due to ethane.

In an actual analysis the computed contributions of the gases to each mass are finally added, and the agreement between these sums and the observed peaks indicates the degree of accuracy of the analysis.

Ethane—4.5% — LIQUID PROPANE — Propane—95% — Iso-Butane—0.5%

Mass	Contribution to Total Peak by Ethane	Propane	Iso-Butane	Total Peak
26	8.1	159	.3	167.4
27	14.2	872	4.7	891
28	59.7	1975	2.0	2037
29	12.0	3060	3.6	3080
30	18.3	103	.1	121.4
37	....	28.4	.1	28.5
38	....	67.8	.3	68.1
39	....	352	2.7	355
40	....	61	.4	61.4
41	....	341	7.9	349
42	....	162	8.1	170.1
43	....	848	30.5	879
44	....	949	1.0	950
57	....	.....	.9	.9
58	....	.....	1.0	1.0

% ISO-BUTANE = $1.0 \times 0.505 = 0.5$ (1)
% PROPANE = $(879\text{-}30.5) \times .112 = 95$ (2)
% ETHANE = $(121.4\text{-}103\text{-}0.1) \times .246 = 4.5$ (3)

Fig. 3. Mass Spectrum of Liquid Propane

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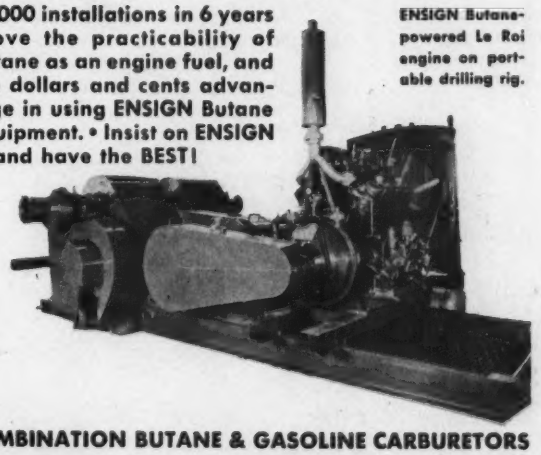

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Figure 4 shows the mass spectrum which would be obtained from a commercial butane containing 0.9% ethane, 35.6% propane, 9.4% iso-butane, and 54.1% normal butane. This analysis would be made in a manner similar to the liquid propane analysis just shown with the exception of the determination of the amounts of butane and iso-butane. In this case, the ratio of the 57 to 58 peak shows that both butanes are present. The amount of each of these constituents is determined by solving the two simultaneous equations shown at the bottom of the figure.

It is evident from the above examples that the mass spectrometer is capable of analyzing hydrocarbon gas mixtures in a direct manner. Furthermore, the analyses can be made rapidly, and the results themselves provide an index of the accuracy of the analysis. Our experience has shown that the data for analyses similar to the above can be taken manually in about fifteen minutes with about ten minutes between runs. Automatic operation of the spectrometer which is at present in the process of development should materially decrease this time. A technician can make the computations for an analysis in a very few minutes.

The gas mixtures so far considered are capable of analysis with the Podbielniak column. The advantage of the mass spectrometer lies in its speed, and in the small quantity of sample necessary for the analysis.

Let us now consider a mixture which requires absorption processes in addition to the Podbielniak column fractionation for its analysis, such as a polymer plant feed stream containing the butenes in addition to the saturated hydrocarbons. Since the butenes do not contribute to the 57- and 58 peaks, the amounts of butane and iso-butanes in the mixture can be readily determined from these peaks as in the preceding examples. Unfortunately, we are unable to say definitely at the present time to what extent it will be possible to distinguish between the four butenes. There is good reason to believe, however, that the mass spectrometer will distinguish between iso-butene, 1-butene, and 2-butenes. The cis and trans 2-butenes will probably be indistinguishable from each other. But the present method of analysis also faces this limitation, and we understand that it is of little practical consequence. The analysis of the polymer plant feed stream for the butenes and butanes by the mass spectrometer should be feasible.

The above discussion is concerned with the application of the mass spectrometer to routine or control analysis. There is another feature which should not be overlooked, and that is the use of the mass spectrometer as an aid to the chemist in the research or development laboratory. For example our laboratory solved the following problem in a somewhat different field. In soil gas analysis for petroleum prospecting one method in which the mass spectrograph is not employed incorporates a very crude form of fractionation of the hydrocarbons extracted from the soil or soil gas. By this method the hydrocarbons are caught in a liquid nitrogen trap and the trap evacuated of air. The temperature of the bath around the trap is then raised a predetermined amount and the total volume of hydrocarbon gas set free by this process measured.

This procedure was checked in our laboratory with the mass spectrometer. The results, stated briefly, were that the percentage of any given hydrocarbon set free from the trap by raising its temperature was not solely a function of the amount of that hydrocarbon present and of the temperature of the trap, but was materially affected by the composition of the mixture originally in the trap. For example, with only normal butane in the trap almost all the butane will be liberated at a temperature of —122°C.. If the trap originally contains a mixture of butane and heavier hydrocarbons, as much as 50% of the butane may be retained in the trap. This data shows that the process was controlled to a considerable extent by adsorption and solution rather than by vapor pressure. This pertinent information was rapidly ob-

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COMMERCIAL BUTANE

Ethane—0.9% Propane—35.6% Iso-Butane—9.4% N-Butane—54.1%

Mass	Contribution to Total Peak by Ethane	Propane	Iso-Butane	N-Butane	Total Peak
26	1.6	59.8	4.9	84.4	150.7
27	2.8	327	88.3	875	1293
28	11.9	742	37.4	830	1621
29	2.4	1147	67.7	1168	2390
30	3.7	38.5	1.5	26.5	70.2
37	.....	10.7	1.7	9.8	22.2
38	.....	25.4	4.8	30.5	60.7
39	.....	132	49.8	339	521
40	.....	22.8	8.1	52.3	83.2
41	.....	128	149	864	1141
42	.....	61	152	460	673
43	.....	318	573	3530	4420
44	.....	356	18.8	104	479
57	.....	.....	17	110	127
58	.....	.....	18.6	418	437

LET p_1 = % ISO-BUTANE
p_2 = % N-BUTANE

$1.81\ p_1 + 2.04\ p_2 = 127$ (1)

$1.98\ p_1 + 7.73\ p_2 = 437$ (2)

$p_1 = 9.4\%$

$p_2 = 54\%$

Fig. 4 Mass Spectrum of Commerical Butane

Each Tretolite formula is developed by exacting scientific procedure in the most modern of laboratories. Such care is your assurance of Tretolite dependability in treating crude or B.S. to pipe line requirements. There is a specific Tretolite formula to fill your need; so call your local Tretolite representative and let him help you with your oil treating problem.
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Figure 5. Mass spectrometer and associated equipment.

tained. There are many other instances where the spectrometer has expedited our chemical work, but time does not permit their enumeration here.

Figure 5 shows the mass spectrometer with its associated apparatus as set up in the United laboratory. The heart of the spectrometer where the ions are produced, sorted, and collected is in a glass envelope placed between the pole faces of the large electromagnet seen in the foreground. The glassware just back of the magnet is for introducing the samples into the spectrometer and for evacuation. The tall rack houses the power supply for the magnet and the 4000 volt accelerating voltage. The two shorter racks contain the recording apparatus and the mass spectrometer controls. The apparatus is arranged so that it can be easily operated by one man.

To sum up, the mass spectrometer offers a new, rapid and direct method of analysis of gas mixtures. It shows great promise of finding practical use in the refinery, in those operations where it possesses distinct advantages over the present methods of analysis. It has already proved its usefulness in the laboratory in expediting development of chemical processes.

In conclusion, the authors wish to express their appreciation to Herbert Hoover, Jr., for his valuable suggestions and enthusiastic support of this project.

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The Brown Instrument Co. has just published a new catalog No. 6706. This catalog covers the complete line of vapor-actuated, gas-actuated, mercury-actuated and portable thermometers for indicating, recording and controlling processing operations.

Advanced design features such as rectangular case, powerful flat spiral actuating elements, overload safeguard, etc. are fully described. A copy of this catalog will be sent on request. Address: The Brown Instrument Co., Wayne & Roberts Aves., Philadelphia, Pa.

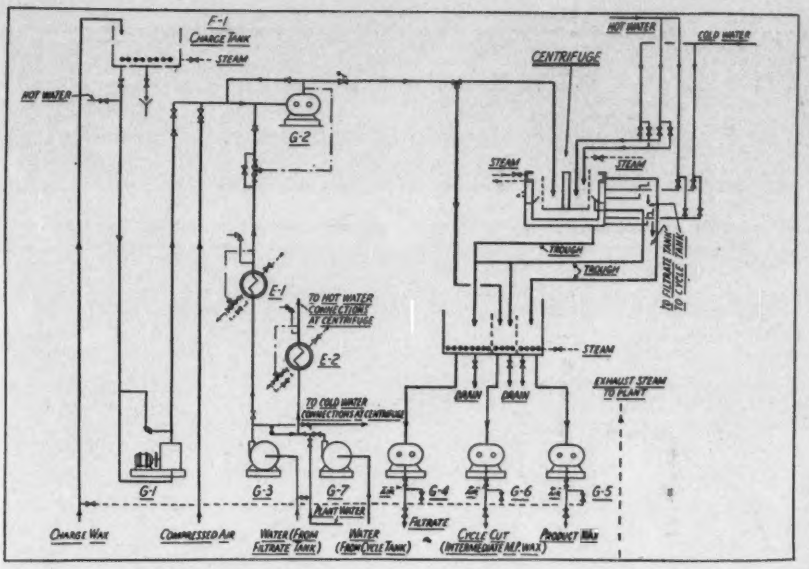
Commercial Butane— A Waste Product

(Continued from Page 27)

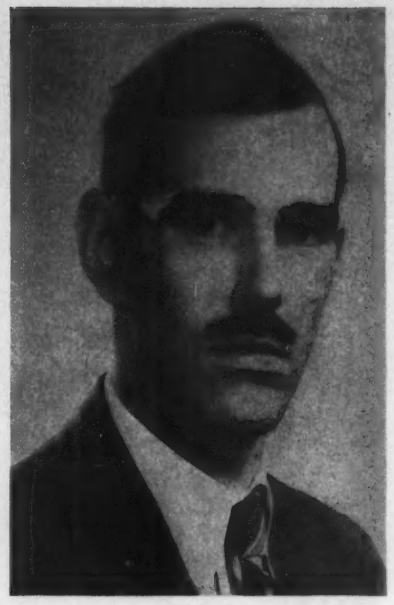
than an actuality. If all of the iso-Butane is taken to alkylate refinery butenes, however, the hoped-for seller's market should become an actuality in 1941.

Even though a demand greater than the supply is not apparent throughout the coming year, peak demands should press some producers to the point of cutting into their natural gasoline production in order to meet their commitments, and should cause an appreciable stiffening of the Butane market, thus forcing the producers and marketers to realize that they have been throwing away a premium product which requires only a progressive, constructive sales program to force it to take its proper place as one of the cleanest, most economical premium fuels available, with an anti-knock rating equivalent to the finest of aviation gasolines.

Five thousand miles of petroleum pipe lines were built in 1939, longest mileage record to date.



The Emulsion De-Oiling Process, utilizing water emulsions to effect continuous wax-oil separation. Discussed in Dr. Schutte's paper.



A. H. Schutte

(Continued from Page 7)

and arrangement of piping. A number of recommendations were made for the continuation of this research.

President H. W. Prentis, Jr., of the National Association of Manufacturers, asserted that American industry need not and cannot be drafted for national defense because already it has volunteered, has pledged, and has given its support to government. "Today, with the defense emergency upon us," he declared, "industry asks of government a fair deal instead of the shabby deal of recent years; faith instead of suspicion; active governmental sympathy and support instead of demagogic criticism; statesmanship instead of politics."

"No private business enterprise would consider for a moment operating on the basis under which the patriotic members of the National Defense Advisory Commission are now forced to function," he added. "An executive head with real authority to coordinate the work of the Commission, to enforce its decisions, to cut through government red tape, to standardize specifications, and thus make possible the full benefit of mass production methods, should be appointed at once."

American production of aviation gasoline of all grades has reached a record peak of about 45,000,000 gallons a month, or more than 1,500,000 gallons a day, and stocks, having more than doubled in the past year, currently amount to about 5,700,000 barrels or nearly 240,000,000 gallons, Fred Van Covern, director of the department of statistics, American Petroleum Institute, told the members.

How much 100-octane super aviation fuel is included in these record stocks and present production is difficult to determine, Mr. Van Covern states, but production of all grades of aviation fuel is far in excess of normal needs. Total domestic U. S. consumption in 1938 amounted to about 100,000,000 gallons, and in 1939 probably was 25 per cent greater.

"Despite the tremendous advances in aviation in this country in the past decade", he said, "few people realize that consumption of motor fuel by airplanes almost has been insignificant in comparison with total motor fuel consumption. In 1939, a record year which saw U. S. aviation fuel consumption increased probably 25 per cent over 1938 to the highest point in history, this demand amounted to less than one-half of one per cent of the total motor fuel consumed in the nation. Because relatively few planes even now have motors designed to use the 100-octane fuels, much of even the 1939 consumption in this country probably was of a quality far below that of the super fuels now wanted for national defense.

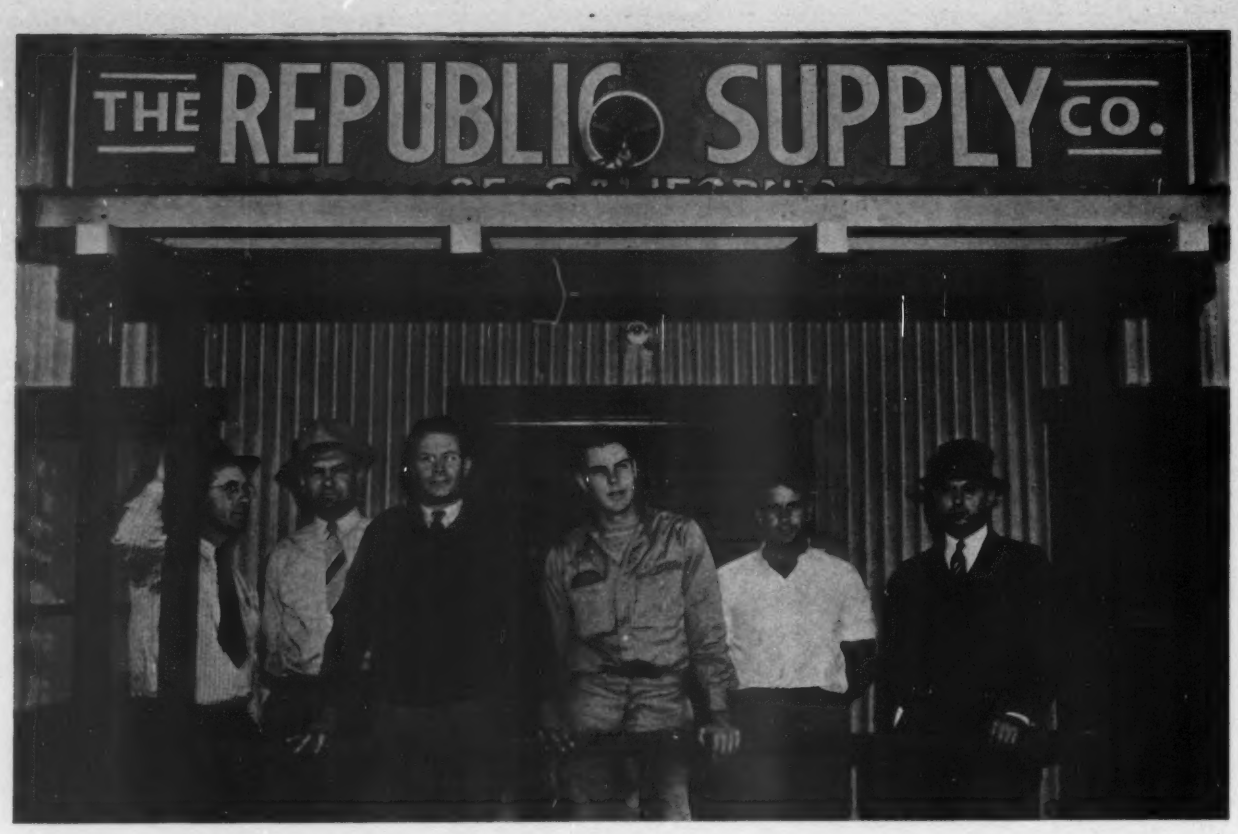
"Although it is not yet certain how much 100-octane gasoline is being made or is in storage, nor how much the industry's refiners are going to be called upon to make, the present stocks of aviation fuel of all grades are by far the greatest in the history of the industry. For the past three months these stocks have been growing at the rate of 9,000,000 to 12,000,000 gallons a month. Stocks at the end of October probably totaled close to 5,700,000 barrels, or 240,000,000 gallons, which is more than twice the total on October 31, 1939. Present production of about 45,000,000 gallons a month of all grades is far in excess of normal aviation fuel needs, and reports indicate that additional capacity now is being built.

"Statistics on aviation gasoline only now are beginning to become available, and data for 100-octane fuel in particular still are meager", Mr. Van Covern said. "However, it is believed that in 1937, the first year of large-scale production, about 7,000,000 gallons were made. In 1938 the quantity rose to 20,000,000 gallons, and in 1939 to 100,000,000 gallons, or roughly equivalent to the total domestic consumption of all grades of aviation fuel in the previous year.

"Effect of increased production of 100-octane and other aviation fuels, to be put in storage under expected government national defense orders, on the normal operations of the refining branch of the industry is uncertain. It is possible that 40 to 60 per cent of these fuels will be base stocks from selected crude oils, and the remainder a combination with high-octane blending agents. If this occurs, piling up of abnormally high motor fuel stocks next spring partly may be prevented because manufacture of large quantities of aviation fuel might tend to reduce total yields of gasoline from crude oil somewhat".

If your local filling station operator touches his hand or the nozzle of the hose to some metal part of your automobile before he removes the cap from your gas tank, he merely is protecting you against the hazards created by static electricity, J. M. Pearson, of the Sun Oil Co., told the members. Oftentimes, he said, the simple precautions such as this

(Continued on Page 46)



To provide service for the new Del Valle field as well as the prolific Newhall and Aliso Canyon fields, Republic Supply Co. have opened their Newhall Ranch Store. It is located approximately one hundred yards southwest of the Beacon station on the Ridge Route. The new store increases Republic's branches to fifteen in all principal California oil fields. Above, left to right ,are: Frank Wiegand, Chiksan; George Gisa, Hughes Tool; H. C. White, Ralph Abbott, Dozier Butler, and Vice President W. L. Duhig, of Republic Supply. Below, the customers, left to right, are: Oscar Pyron, Pacific Western; Frank Fee, Bolsa Chica; Lou Bering, Lincoln Petroleum, and Ed McWhirter, R. E. Havenstrite, Operator.

LAUGH THIS OFF

They had been bothered with a cat out at one of the Santa Fe Springs pump stations and a rousty had been commissioned to dispose of the animal. Some time later he wandered into the station and enquired, ominously, "Do you remember drowning the cat?". "Sure", replied the engineer. "Well", continued the rousty, "It came back". "That's quite a coincidence", said the engineer, "The cat came back, too".

Reminding us of the little boy who cried bitterly when his father drowned the kitten. It seems that the dad had promised the little fellow he could do it.

And switching animals in the middle of the stream, **Phil Rockfellow** has one of the best watch dogs in Glendale. The minute Phil hears a suspicious sound, all he has to do is wake up the dog and it barks to beat the band.

Wherewith **Ben Moeller** tells about a geologist who was given an assignment in a hitherto unexplored territory back in Kentucky. He took up his residence in an obscure community, and almost immediately the neighbors began to drop in. They were obviously quite hostile, a circumstance he couldn't understand until one night a delegation of townsfolk waited on him. "Why did ye move amongst us effen ye wuz suspicious of us?" asked the leader. "I'm not suspicious of you", protested the geologist, and the head of the posse came back, "Well then whut did ye lock yer tool shed fer?. Ye shoulda knowed nobody in them parts never steals nothin' to work with".

On the subject of work now, a young college graduate was recently given a job by a local equipment supply house, and was told first to get familiar with the stock. So he started right away with the stenographers.

Which recalls **Charley Chandler's** story of the stenographer who worked for a bow-legged boss for years and finally fell through his lap.

Confidentially, we ourself have a pair of the best chippendale legs in the West. After he was too old to spank, Junior described them once as "few and far between".

Now comes our old friend **Mack McKinnon** citing the case of the Scotch lady who in a burst of generosity last Thanksgiving shouted, "To heck wi' the expense. Gie the canary anither seed".

And when **Dave Kilgour** was asked if golf was a Scotch game, he promptly replied, "Oh no, it can be ployed equally weel wi' rye or gin".

On the same general topic, **George Anderson** gives a fine illustration of Scotch thrift in the story of the two wayward Scotch laddies who threw a brick at a jeweler's window, and decamped with a substantial haul. They were arrested on the following day when they came back for their brick.

Our old friend, **Scotty Connelly,** incidentally, swears he is not going to buy another atlas until world affairs become more settled.

If there is any basis for the belief that the radio will soon be playing a big bit in war, we are all prepared. We have certainly faced some awful programs.

And **Tom Taggart** still thinks that Paul Revere probably started the whole sordid radio mess, when he ran all over the country broadcasting from a single plug.

Saying which, **Russell Havenstrite** informs us about an oil man and his wife who took to horse back riding but will never take the bridle path because they think it's for newlyweds.

Did you know that all ladies used to ride side-saddle? There was method in their madness, too. You see, that left one little spot on which they could sit down the next day.

Harry Lee our long standing expert on self defense comes in at this point with a new (to us) fight yarn. Says the boxer to his manager, "Do you think I've hurt him?" Replies the manager, cruelly, "No but keep on throwing punches. The draft may give him a cold".

And, chirps **Doc Curtis,** breezily, "How do you feel this morning?" "Fine", answers the patient, "But I'm having quite a bit of trouble with my breathing". "Well, don't worry", says Doc, as he rolls up his sleeves, "I'll soon stop that".

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(Continued from Page 43)

are the most effective in preventing accidents.

Seldom does a tested safety measure fail to work, Mr. Pearson reported, and when it does fail, either the remedy has been misapplied or other factors not accounted for have been present. Even lightning striking gasoline tanks is substantially harmless if the tanks are of modern all-steel construction and gas tight, he said.

An automatic fire extinguisher built into tank trucks, which may prove as revolutionary in the field of automotive transportation as was the automatic sprinkler when first used to safeguard commercial buildings, was also explained to the petroleum industry's transportation experts by J. F. Winchester, of the Standard Oil Company of New Jersey. This safety device, he said, is still in an experimental stage, but if it proves as successful as is now indicated it will be a boon to the industry.

Mental characteristics are as important as physical characteristics in the selection of good truck drivers, R. B. Roaper, of the Humble Oil and Refining Co., declared. A driver may satisfy all the necessary physical requirements, he said, and still be undesirable for the job because of improper weight, nervousness, or other body or mental diseases.

"An application," he declared, "should have sound reasoning power, a good reaction time, a sense of judgment, and the ability to get along with people. One who is easily provoked or who insists upon or demands his rights, soon will take advantage of the other person's shortcomings, even if the result is a severe wreck causing possible death."

Mr. Roaper also asserted that the "old dog" can be taught new tricks through the interchange of ideas at safety meetings, where he can use the valuable stores of his past experience to curb the reckless, impulsive, eager ideas or inventions of the newcomer, and between them a practical, sane improvement in either method or equipment can be reached.

Other speakers at the session included J. W. Sinclair, of the Union Oil Co. of California, Los Angeles, Calif., who discussed some of the equipment problems of automotive transportation; title of his paper was "Should Gross Weight Limitations Be Universal?"

Flashlight Bulb Extension is Useful

A novel flashlight bulb extension has been developed for use in every industry and trade. It can be used to inspect the "innards" of machinery, chemical equipment, and intricate parts, bringing light to inaccessible places where no other light can reach.

Made in lengths of from 6" to 36", its plug end is screwed into any flashlight with the bulb in the opposite socket. Being bendable, it can go down into tortuous passages or in a maze of wiring or gears, down in molds or cavities, inside of cylinders of combustion engines for minute inspections, etc.

Engineers, inspectors, and maintenance men, find it a convenient device. Being fully insulated, it can be projected under water and into various solutions, and inside of motors. It can be bent, too, to form a hook to be used as a trouble lamp, or fashioned into its own stand and placed to project light where needed, leaving both hands free to work.

Known as the Sierra Flashlight Bulb Extension, it is made of special copper wire encased in high grade aluminum alloy tubing. This new device is made by the Sierra Aircraft Co., Sierra Madre, Calif.

General view of Union Oil Co.'s new San Francisco office building, located on historic Rincon Hill, in San Francisco, at First and Harrison streets. The new building was officially opened Oct. 17, in commemoration of the founding of the company fifty years ago in Santa Paula, Calif. Ultra-modern in design, the new structure has been surfaced with buff-colored terracotta, combined with glass brick, surmounted by a tower surfaced with orange and blue glazed terracotta.

Recent experiments with super aviation fuels have shown a 55 per cent increase in miles per gallon at 20 miles an hour and more than 40 per cent increases at higher speeds, with important gains in performance.

From the first recorded commercial production of petroleum in the United States, in 1859, to the present day, the earth has yielded 32,250,000,000 barrels of crude oil—enough to fill a box 1 mile square and 1⅓ miles high.

Purchasing Personalities

By Leo S. Busby
Associate Editor
Southwest Purchasing Agent

The Good Old Summertime

This year of 1940, more than any other in history, is rapidly becoming the year of the big question mark. With the important national presidential question finally answered, there are still many vital questions troubling the public mind. Will Great Britain go down to ultimate defeat? Will the United States finally get into the holocaust? Should America feed the starving millions of subjugated Europe? Will ———? Should ———? When ———?

But these are all great world questions and only time and history can reveal the answers. There is another question, however, that every purchasing agent

L. W. Barrington

hears a dozen times a day about this time of year—a more normal, closer-to-home interrogation. He hears it from his associates, from visiting salesmen, and from his friends. It pops up every now and then when conversation lags; it becomes the opening wedge for many a sales argument. It's none other than that old perennial: "Where'd you go on your vacation?"

Since this time-worn question seems to hold such universal interest, it occurred to us that "Purchasing Personalities" for this month, might serve a worthy purpose by presenting a brief resume of oil company P. A.'s summer activities. Forthwith, we canvassed the P. A. offices and here's what we came out with.

Unquestionably, the most enthusiastic vacationist we ran across was L. W. Barrington, of Standard. We wish space would permit the use of his most interesting story of the excellent fishing at Lake Taweel on the Cariboo, seventy-five miles north of Kamloops, in British Columbia. He tells of Kamloops trout, thirty

John P. Healy

inches long, weighing seven to nine pounds, and plenty saucy. The accompanying snapshot shows they were plenty plentiful, too. Any of you Isaac Waltons who like them big, and fat, and numerous might contact Mr. Barrington for further details. We're sure he'd be delighted to tell you stories to make your mouth water.

While we're visiting Standard, let's see what the other boys did this summer. E. A. Conrad took the wife and enjoyed two restful weeks on the San Lorenzo River in the Santa Cruz mountains. R. A. Porter, also with the Mrs., toured the coast to Portland, taking in all waypoints. A. E. Lagerquist with his family divided his two weeks between the local beaches and San Francisco. W. A. Bardwell and family spent their off period in the High Sierras. W. R. Brocklehurst and family cabined at Lake Arrowhead. L. E. Bushard spent two lovely weeks painting his house and avers that henceforth he's a firm believer in "each to his own trade". He hasn't got all the paint out of his hair yet. And finally, a last minute report advised that C. H. Tuttle had chosen the month of November to invade the Napa River country in search of striped bass.

Bill Westergard and Holly Hayter

We hope that John Healy, of Bankline, reads that item about Kamloops trout. John is a confirmed salt water fisherman and spends his vacations hauling 'em over the side. He says there's more fight in a 38 pound yellowtail than there is in a ton of mountain trout. The one in the snapshot broke his pole but John's Irish determination quelled the yellow peril. John's boss, R. C. Boroff, P. A. at Bankline, spent his vacation on a trip back to Ohio to eat Thanksgiving turkey with the home folks.

Speaking of out-of-state vacation trips, W. C. Wickersham, P. A. of Belridge, took a grand one to Glacier National Park and thence to Columbus, Ohio. There he met his son and the two drove back to L. A. in the latter's new car. H. C. Drake, assistant to Mr. Wickersham, divided his two weeks between home and Lake Arrowhead.

Perhaps, one of the most unusual and interesting vacations enjoyed this summer was that taken by Bill Conroy, assistant P. A. at Wilshire. Bill spent two weeks aboard the U. S. S. Saratoga as an Ensign—Supply Corps. in the U. S. Naval Reserve. Wish we had a picture of Bill in his uni.

Over at Union the boys evidently couldn't get over the fact that H. C. Farquhar, Manager of Purchases, got five weeks to travel all over the Pacific Northwest, and to enjoy a well-earned rest at his Newhall Ranch. This, by virtue of his thirty years of union with Union. Most of the lads just figured their two weeks were hardly worth mentioning. We did, observe that Buck Weaver spent some of his time at the P. A.'s national convention at Cincinnati.

At Richfield, the boys really went places with Richfield. C. H. Stuart stepped out and back to his old home in New York City. E. V. Squires journeyed to Kansas hitting the high

spots on the way—Grand Canyon, Boulder Dam, and the Carlsbad Caverns. K. E. Bennett was also a Kansas tourist. But some were content with the home state. R. E. Barker did some fishing in the Little Kern River with gratifying results—he says. H. E. Davis chased a little white ball on the fairways and in the rough at Del Monte. A. T. Flanigan took in the fair at San Francisco and visited with relatives in that city. A. C. Martin went fishing with less than no results in Humboldt County. Better read our opening paragraph again, A. C. E. P. Hoffman is still waiting for the green light. He hasn't had his vacation yet and enjoys tormenting the boys by talking about it. And H. H. Kelly—ah, there's a mystery—he took his vacation in October. But where or how? Who knows? H. H. won't talk!

Bill Westergard, of Hancock, is another fisherman of no inconsiderable success. Bill entertained his son Tex and wife at Lake Arrowhead during August and reports unlimited limits. Tex, incidentally, is in the oil business at Houston, Texas. Bill Albers, assistant P. A. of Hancock, takes after his boss and evidently uses the same technique for he, too, speaks frankly of unlimited fishing success at Glacier Lodge, near Bishop.

Holly Hayter, of Tide-Water Associated, an inveterate fisherman, forsook the rod and reel this summer to spend most of his vacation around home and at Del Monte, shooting golf. Mart Newell, Holly's aide-de-camp, chose San Clemente for several very disappointing fishing excursions. To Mart, also, we heartily recommend our opening paragraph.

Mart Newell

Charley Keeble, genial P. A. of Union Pacific, was chairman of the L. A. delegation to the P. A.'s national convention at Cincinnati.

At General, the boys also got around a bit. Bill Beck flew to Detroit, picked up a new Olds, drove to the convention at Cincinnati, and thence back by way of the old home town in Missouri. Paul Whiteley studied the solemn silence of the big trees at Sequoia, and laid awake nights trying to visualize the C.C.C. unit that planted them. Frank Scott took in Lake Louise, and other points in British Columbia, and almost precipitated an international situation by mailing postcards in Canada with U. S. stamps on them. Jimmy Ross did the Pacific Coast from L. A. to Grants Pass the first week. He slipped away without his family and when his wife found out about it, he had to spend the second week doing it all over again. Charley Schneider took his time-out at Seven Oaks. He took his dog along, too. The dog had a grand time.

And so, comes the end of another vacation season and the end of our space. May we close with the hope that the prosperity of 1941 will afford bigger and better vacations for all of us.

Standard print is twisted into odd shapes for trick advertising photography by rods of transparent plastic placed over the letters.

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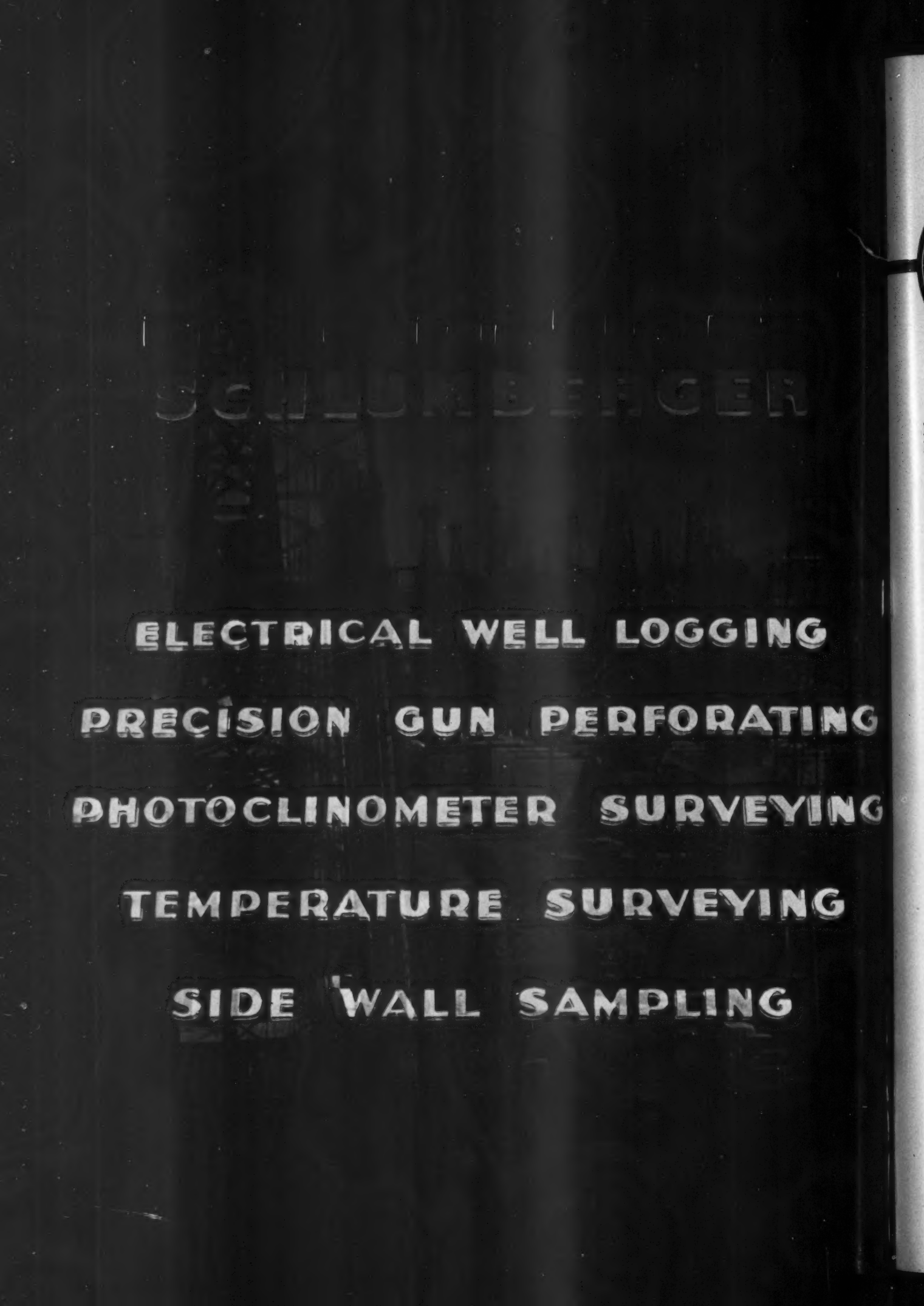
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Field Development

Los Angeles Basin

Havenstrite Tests Fifth Dominguez Well

R. E. Havenstrite, Operator, is testing Larronde No. 5 after gun-perforating several intervals above bottom at 7818 ft. Most southerly well on the property, it is also the lowest structurally but enough oil sand was found to warrant expectations of a fair well.

The Havenstrite organization has derrick up for No. 6 which will be the most westerly well in the field. A new power rig has been purchased to drill this one.

Callender No. 79, Union Oil Co.'s deep test, is coring below 9700 ft. Little information has been released but it is understood that some streaks of tight oil sand have been encountered below the Eighth Callender Zone.

Union is completing Callender No. 80 at 7414 ft. and is drilling Carson No. 15 and Austin No. 6. In the center of the field, Shell Oil Co. is drilling Reyes No. 109.

Midfield Tests Rosecrans Well

Midfield Oil Co. is testing its important well in the easterly section of the South Rosecrans area with a good chance that production will exceed that of the other tries in the vicinity. Only the 200 ft. immediately above bottom at 8250 ft., Eighth Zone, are being tried at present.

Completions in the Main Street area have been comparatively small of late, the best being St. Anthony Oil Co.'s No. 6 which was estimated at four to five hundred barrels. New wells by Kelly & Sons, Inc., and Royalty Service Corp. were in the 200 bbl. class.

Wilmington Activity Still Holding Up Well

Activity is still holding up in the Wilmington field though it will celebrate its fourth birthday next month. Development work is scattered throughout the field but is most active in the northwest area where productive limits are not yet in sight. On the structural nose reaching out toward Torrance 300-bbl. wells are not uncommon, one of the latest being Martin-Miller Oil Co.'s Huck Comm. No. 1 which bottomed at 3712 ft. after setting casing at 3020 ft. Several wells are drilling there now and at least half a dozen more are scheduled for the next few weeks.

On the Gremac property near Cerritos Channel, Sea Shore Oil Co. got a surprisingly good well in No. 4 whose initial was estimated at 1000 bbls. a day. Three intervals are produced from 3000 ft. to bottom at 3750 ft.

In the heart of the field, Union Pacific Railroad Co. and Long Beach Oil Development Co. continue to bring in good producers in all zones from the Ranger to the Ford.

LOS ANGELES BASIN WILDCATS

Area	Well	No.	Section	Depth	Status
Athens	Rankin & Williams	1	7, 3-13	6520	Cleaning out
Castaic	Colter, R. T., Explor.	1	8, 4-17	1338	Idle
	Havenstrite, R. E., Lincoln	2	16, 4-17	3840	Drilling
	Pedro Pet. Co., Oates	1	24, 5-17	2205	Idle
	Worland Oil Co., Jenkins-Owens	1	18, 5-16	2790	Idle
Dominguez, West	Wood-Mellon Oil Co., Wood	1	31, 3-13	7498	Testing
La Habra	Fullerton Oil Co.	6	25, 2-11	5918	Drilling
Mint Canyon	Redwood Oil Co., Mitchell	2	22, 4-15	1598	Drilling
Malibu	Sovereign Oil Corp., Sovereign-Marblehead	1	7, 2-18	3469	Idle
Newhall	Canyon Oil Co., Sanborn	1	6, 3-16		Rig
	Creighton Hammon Synd., C. H.	1	17, 3-16	990	Idle
	Irene Oil Co., Kraft	1	31, 4-15	30	Idle
Palos Verdes	Rolling Hills Pet.	1	27, 4-14	6580	Idle
Torrance-Wilmington	Silver Pet. Co.	1	30, 4-13		Rig
	Bristol Oil Co., Spring	1	30, 4-13		Location
San Fernando	Casa Grande Oil Co., Lopez-Lundy	1	1, 2-15	3785	Idle
West Whittier	Cal. Pico Oil Co., Beach	1	7, 2-11	7712	Drilling
	Orange County				
Costa Mesa	Thompson, Milton N., Banning	1	9, 6-10	5649	Idle
	San Bernardino County				
Carbon Canyon	Earp, H. R., Kraemer-Backs	1	34, 2-8	1200	Drilling
	Kipp, George, Inc., Bannon	1	32, 2-8	869	Cleaning out

NORTHERN COUNTIES WILDCATS

County	Well	No.	Section	Depth	Status
Madera	Blake, T. N., Arnold	1	22, 10-17	3204	Bailing
Merced	Don Pedro Oil Co.	1	9, 6s-9e	1906	Idle
Monterey	Loma Grande Oil Co., Corey	1	23, 24s-10e	1581	Fish d.p.
	Priest Valley Pet. Co., Greve	1	22, 20s-12e	2885	Cem. csng.
Sacramento	Independent Exp. Co., Perry	1	19, 7n-6e	1650	Drilling
San Joaquin	Standard Oil Co., Blewett	1	25, 3s-6e		Foundation
San Mateo	Ra-Lite Petroleum, Inc., Bell	5	16, 7s-4w	1200	Drilling
Yolo	Standard Oil Co., Tippets	2-1	9, 12n-3w	2455	Stdg. plugged
Yuba	Wright, L. G., Cox	1	18, 14n-5e	1830	Cleaning out

A new spurt is getting under way in the Long Beach area north of Ninth St. between Pico and Santa Fe with new projects being started by Hamilton Oil Co. and Arthur J. Louden.

Barnsdall Completes Rancho San Francisco 14

Barnsdall Oil Co. finished Rancho San Francisco No. 14 flowing 389 bbls. a day of clean oil through a 13/64-in. bean. The liner is perforated in two intervals, 6989-7019 ft. and 7060-7205 ft.

Barnsdall is drilling No. 15 near 6800 ft. and is rigging No. 16.

Second Lincoln Well Drilling Below 3600

R. E. Havenstrate, Operator, is finding the going rather slow in Lincoln No. 2 at Del Valle, having just passed the 3600 ft. mark. Fractured zones are said to have caused much circulation trouble.

Deep L. B. Well Sets Protection Pipe

Union Oil Co.'s deep Long Beach well, L.B.C. No. 19, should have solved its circulation difficulties with the 9-in. protection string now standing cemented at 5900 ft. The hole will be carried to the 10,500 ft. level.

Athens Wildcat Nears Old Depth

Rankin & Williams are nearly down to the 6520 ft. bottom of the old Entrikin well on the golf course at the corner of 120th St. and Main. Never cased, the walls of the hole were found to have caved badly.

Pico Well Drills Below 7725 Feet

The Cal-Pico Oil Co. is drilling below 7725 ft. in its wildcat located on Durfee Road midway between the Montebello and Whittier fields. Showings have not been too good and the hole may be plugged for a test of shallow sands.

New Well Planned For Redondo Area

California Oil & Refining Co. which heretofore has confined its activities to refining is planning to drill a wildcat half-way between the old Hunter-Devlin well and the sea. The try will be located south of the west end of the Redondo-Torrance field and will seek production in the equivalent of the Torrance Main Zone.

United Pet. To Deepen Monterey Park Wildcat

United Petroleum Co., newly formed by a group of Los Angeles winery men, is reported rigging up to deepen the old Wales Petroleum Co., Ltd. Haig No. 1 at Monterey Park. Located about two miles north of the Montebello field, the well was drilled to 3370 ft. during the summer of 1937.

West Dominguez Well Fights For Fluid

Still laboring to get through a restricting sheath of cement behind 5½ in. casing cemented on bottom, Wood-Mellon Oil Co. is working to get fluid in the hole.

Originally drilled to 7498 ft. where 7th and 8th Callender zones were found barren, the West Dominguez wildcat was directionally redrilled to 6975 ft.

The new hole, directed southwest to a bottom near the intersection of Victoria Blvd. and Figueroa St., is said not only to have gained height on structure but to have found more and better saturated sands than were found in the original straight hole.

Torrance-Wilmington Wells Waiting on Current Test

With several wells planned for the recently re-zoned area near the intersection of State and Figueroa, where it is suspected a meeting of Torrance and Wilmington production exists, activity is in abatement until Silver Petroleum Co. has finished its test now rigging up.

Located half a block east of Figueroa and just north of State Street, the new project started under the name of American Oil Co. and has only been recently turned to the Silver Petroleum Co. Believed by many familiar with the area to be high on the structure, this well is expected to clarify doubts concerning the area which arose after the poor showing of Vesta Petroleum Corp.'s well just southwest of the intersection.

A few blocks north of this play, at the southeast corner of "R" and Figueroa, Bristol Oil Co. is planning to drill Spring No. 1.

Union Oil Drills Coyote Deep Test

Finding the Riley zone largely shale, Union Oil Co. is making a deep test of its Toussau No. 2 in the westerly section of the East Coyote field. Though it is believed sufficient sand was encountered to make a fair well, the interval between 6000 and 7000 ft. was not as good as expected so the hole is being deepened below 7425 ft. to seek new producing horizons in the Miocene.

On the north flank of the central portion of the field, California National Oil Co. is drilling at 2300 ft. in its offset to the successful Sonwell wells. Graham & Loftus Oil Corp. are preparing to redrill and deepen No. 16 in the old proved area.

Small production of wet oil was obtained by Barth Oil Producers after perforating Queyrel No. 1 at intervals from 2700 to 3100 ft. The hole was plugged back when the Lemke zone was found unproductive at 4300 ft.

Good Well Completed In Old Brea Canyon

That Brea Canyon, one of California's oldest fields, is far from washed up was proved by Shell Oil Co. when it completed Orange No. 21 pumping 300 bbls. of 28 gravity oil per day. Hole was bottomed at 5228 ft. and plugged to 5080 ft. where the liner, perforated at intervals below 4300 ft., was landed.

Signal Finishes Two In Huntington Beach

Signal Oil & Gas Co. completed two more good wells on the Bolsa lease at the west edge of the Huntington Beach Old Field with the highest rate registered by No. 24A. Bottomed at 3450 ft. in the Ashton zones, production gauged initially 675 bbls. a day of clean 28 gravity oil. No. 24, completed at 4855 ft., flowed 600 bbls. Signal has two more projects nearly ready for completion as very little time is lost between jobs and drilling is relatively easy.

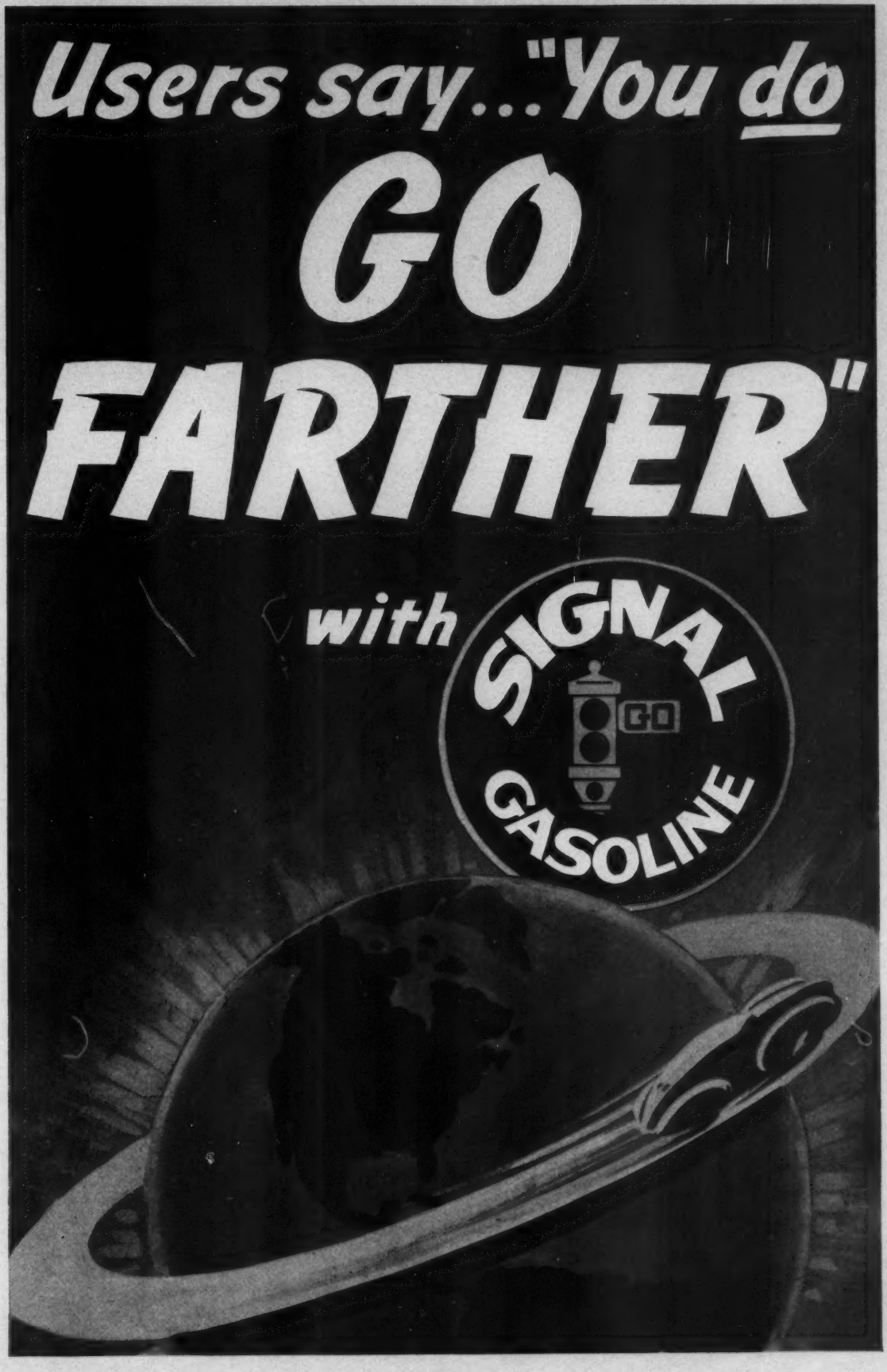
In the central part of the Old Field, Harold C. Morton is drilling on an old Tide Water Associated lease while on the Ocean Front, Southwest Exploration Co. is completing No. 33 and is getting ready to drill No. 34.

B.M.W. Oil Co., Farnsworth No. 3, located on the flat east of the main field, is reaming to straighten the hole with bottom at about 4600 ft.

Standard Tests Inglewood Zones

While drilling Rubel No. 26, Standard Oil Co. is carefully testing practically every foot of the hole in intervals of 50 to 100 ft. Two tests between 3350 and 3500 ft. were particularly good, the fluid reaching the surface in eight minutes in one trial and rising 2880 ft. in 45 minutes during the other. All tests have been free of water. Last reported depth was 3660 ft.

Los Angeles Investment No. 3-1, Standard's offset to the R. R. Bush deep discovery below 7000 ft.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San Joaquin Valley

Activity Reported From Valley Fields

Activity in the Belridge field remains generally static with Belridge Oil Co. running three strings while Continental Oil Co. drills one well on the Result lease.

In the Buena Vista Hills, Honolulu Oil Corp.'s deep try, No. 25-P, is coring silty gray sand at 10,295 ft. with no important showings logged to date.

Ohio Oil Co.'s KCL E-21, the lone driller at Canal, was last reported fishing iron from bottom at 6645 ft.

Coles Levee remains the most active of all with 18 strings turning to the right. Development is generally centered in the northwest section of the field where both the black oil and gas cap sections are receiving attention. Movement in this field has moved the proved limits well up to the easterly slopes of the Elk Hills.

Amerada Pet. Corp.'s S.P.L. No. 37-17, deep test in the Coalinga Northeast area, apparently failed to find Cretaceous showings since the drill was stopped at 9515 ft. and casing set over the Eocene Gatchell sands at 8339 ft. for a normal production effort. Eleven strings are active in this half of the Coalinga twin field, and represent the work of seven operating companies.

Coalinga Eocene Pool development proceeds with customary vigor with all sections of the shoreline pool receiving attention. Superior Oil Co. is working the Cagle lease at the north flank, Universal Consolidated Oil Co. is drilling Binkley No. 4 at the south flank, while Robt. S. Lytle and Standard Oil Co. continue development of the entire central section of the field. Operating on the smallest lease in the area, E. L. Cord is drilling No. 1 below 6500 ft. on a 5-acre parcel in the southeast quarter of sec. 6,20-16.

Another of the deep wildcats generally predicted for the ensuing year is scheduled for the Elk Hills field where Standard Oil Co. has located No. 42-31S in sec. 31, 30-24.

The northwest section of the Greeley field is represented by light drilling rigs which complete and spud with regularity. General Petroleum Corp., Standard Oil Co., Superior Oil Co. and Wilshire Oil Co. are the participating companies.

Two shallow wells, D.B.K. Co.'s No. 12 and Stephens Oil Co.'s No. 1, are working in the old Kern River area.

Kettleman North Dome is the arena for ten rigs, five of which belong to KNDA, four to Standard Oil Co., while the tenth is being drilled by Robert S. Lytle on the Felix lease.

In the huge Midway Sunset field, Alford Oil Co., Marvic Associates and North American Oil Consolidated are drilling, while Merritt Annex Oil Co. and Republic Petroleum Co. have each finished one of the small pumpers current in the field's history.

At Mount Poso, Ring Oil Co. is planning to drill Bowles No. 20-11 in sec. 29, 26-28.

Paloma was credited with another excellent Stevens zone producer when Western Gulf Oil Co.'s KCL No. A-34-2 was completed through a 24/64-in. bean flowing 720 bbls. of 54.5 gravity clean oil and 6,500,000 cu. ft. of gas. Western Gulf has moved to the southeast and is drilling No. 12-12 below 7800 ft. while at the westerly edge of present proved limits Ohio Oil Co.'s No. A-9-83-4 is nearing 7000 ft.

Six wells will soon be finished in the Rio Bravo field, one of which belongs to General Petroleum Corp., two to Superior Oil Co., and three to the Union Oil Co. Development is being done at a consistent rate and has added millions of barrels to California reserves during its three-year history.

The first try at the Vedder zone production believed to underlie the producing Stevens zone at Strand is well under way with Tide Water Associated Oil Co.'s KCL No. E-25-7 last reported in chert at 10,330 ft.

Shell Oil Co. is running four outfits in its individually controlled Ten Section field with two having set casing to complete from 8250 ft.

Pacific Western Oil Co. and Standard Oil Co. are each drilling a well to the sands below 13,000 ft. which make Wasco California's deepest oil field.

Prepare To Spud 2nd Mendota Try

In the Mendota area of Fresno county, some 20 miles northwest of Coalinga, Jergins Oil Co. and a syndicate of other companies have spudded Cheney Ranch No. 2 with actual drilling contracted by Kern Drilling Co.

The current try is in sec. 29,14-13, a short distance southeast of No. 1 which occasionally bleeds off a little gas from sands near 7000 ft. Several tests were made during the original drilling which carried the well to a maximum 9345 ft.

It is believed that No. 1 found showings of an accumulation which might prove profitable in a well higher on the suspected structure. The original location was indicated through the use of soil-analysis and as such has proved of considerable

SAN JOAQUIN VALLEY WILDCATS

Area	Well	No.	Section	Depth	Status
Fresno County					
Cantua Creek	The Texas Co., Everding	1	24, 17-15	10307	Abandoned
Coalinga	Classen, W. J. & Assoc.	1	1, 21-14	1874	Abandoned
	Lewis, C. H.	1	18, 21-15	2298	Idle
	Tide Water Assoc. Oil Co., Guardian	23	2, 20-15	3731	Pumping
Gatos Creek	Gatos Creek Oil Co.	1	19, 19-13	701	Drilling
Mendota	Jergins Oil Co., Cheney Ranch	1	29, 14-13	9345	Idle
		2	29, 14-13	500	Drilling
Kern County					
Belridge—South	DeLanty & Sutton, Trustees	1	28, 28-22	3020	Idle
	Santa Mora Oil Co.	1	10, 28-20	55	Idle
Devils Den	Hersog, R. D., Marine	28	26, 25-18	80	Drilling
	Trigg, H. C.	2	11, 11-11	954	Pumping
Edison	Goodrum & Vincent, Inc., S.P.	7	31, 29-30	460	Idle
Grapevine	Kern Line Oil Co.	1	19, 11-19	8200	Drilling
	Richfield Oil Corp., Tejon Ranch	1	2, 10-19	8472	Drilling
McKittrick	Smith, Ebert E., Smithhart	1	34, 30-22	987	Drilling
Richgrove	Borget, A. J., Kendall	1	16, 25-27	40	Idle
Round Mountain	Spartan Drlg. Co., Hiatt	1	32, 28-29	2085	Idle
	Trico Oil & Gas Co., Westco 1A	A	8, 28-29	1452	Sanded up
Shale Hills	King & Luftig	1	33, 26-18		Location
Strand	Tide Water Assoc. Oil Co., KCL 56-8		8, 30-26		Location
Union Avenue	Hancock Oil Co., Roberts	1	6, 30-28	1250	Drilling
Wheeler Ridge	Richfield Oil Corp. KCL 2		28, 11-20	10934	Rng. csg.
Kings County					
Pyramid Hills	Pyramid Prod. Co., Spreckles	2	16, 24-18		Grade
	Tide Water Assoc. Oil Co., West Slope	31	20, 24-18	1970	Drilling
Reef Ridge	Blair Oil Co., Blair	1	24, 23-16		Rigging up
Tulare County					
Trico	Union Oil Co., Seymour	1	20, 24-23	2461	Completed

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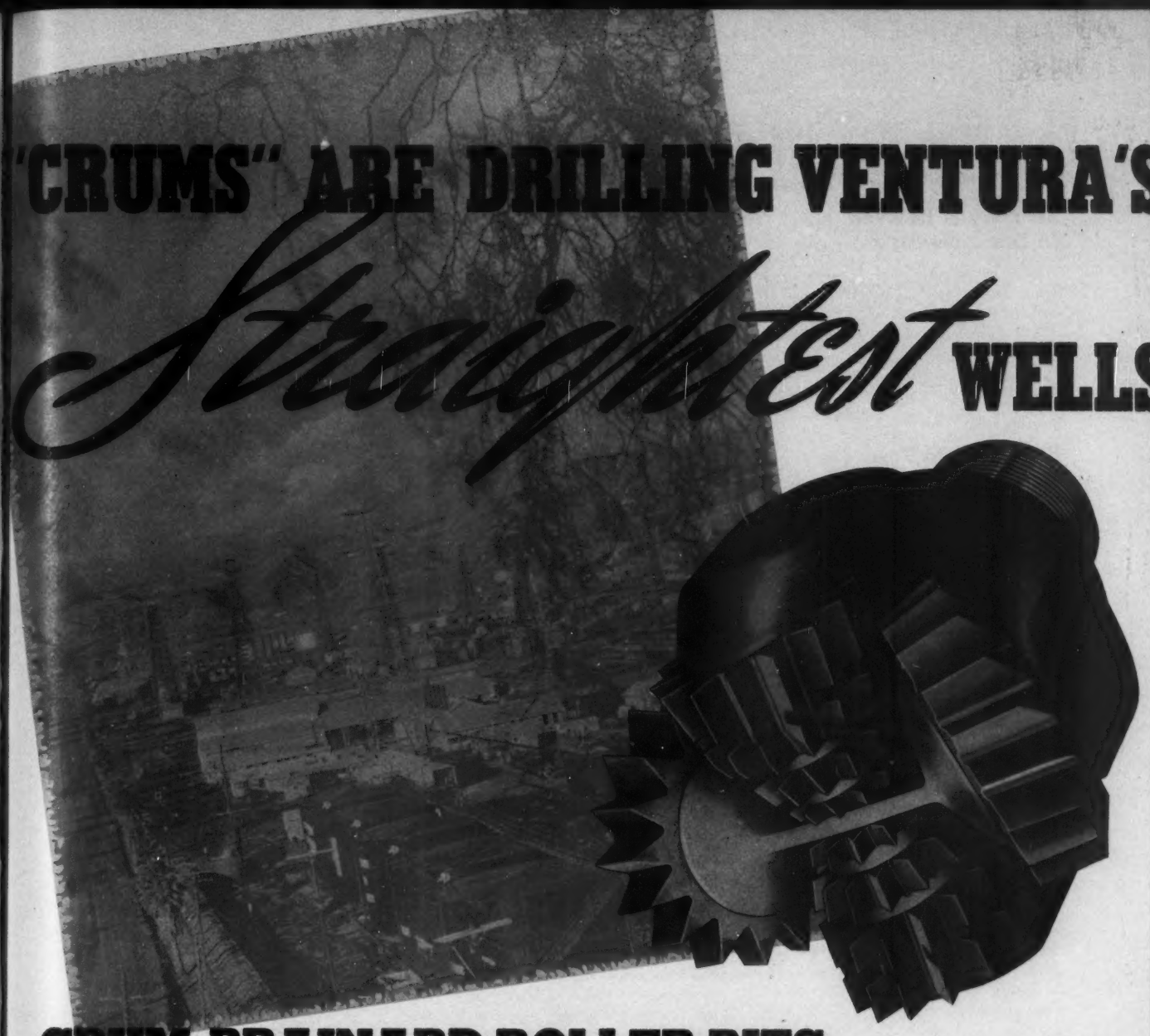

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Two Wells Revived In Lost Hills Area

With its long quietude disturbed by two scheduled projects, Lost Hills has again entered the drilling show.

Argo Petroleum Corp. is rigging up to recondition its 1332-ft. Farnsworth No. 1A in sec. 11,26-20, while Randon Petroleum Corp. is preparing to deepen Theta No. 1, a 1625-ft. hole in sec. 3,26-20.

Kern Line to Test Grapevine Showings

With promising sand bodies logged at intervals from 6730 ft. to last reported bottom of 8200 ft. Kern Line Oil Co. plans soon to stop the drill, run casing and gun perforate for tests of the sand fingers. Drilling Well No. 1 near the center of sec. 19,11-19 north of the Grapevine Pool in southern Kern county, the company admits that core recoveries have been very poor, but claims that oil sand fragments recovered at several points indicate that tests are warranted.

Further confidence in the well is bolstered by the favorable resistivity curve shown on the electric log. While it is conceded possible that the curve might be misleading due to low pressure or contaminated water sands, most observers now admit that tests are in order.

Showings in this well excite more than usual interest due to the fact that the well is located in and near numerous small parcels which would be thrown open to the drill by a strike; a condition hopefully anticipated by most independent operators.

Texaco To Seek Buttonwillow Closure

Location of S. P. No. 47-15 in sec. 15, 29-24 by The Texas Co. brings action once more to the Buttonwillow area which has twice been the scene of deep drillers during the last two years.

Located almost on a line drawn between its two predecessors, the current try will seek accumulations suggested by showings in the other wells. First to bore below two miles here was California Exploration Co.'s Salisbury No. 1 in sec. 7,29-24. This well, bottomed at 12,989 ft., showed many intervals of fine tight oil sands which proved too impermeable to afford a reservoir for accumulation. Final tests of Mulinia gas sands near 4600 ft. also proved weak and the well was abandoned.

Next to drill was Union Oil Co.'s Bowerbank No. 4-23 in sec. 23,29-24 which carried to an unfruitful 12,144 ft. This well also showed many streaks of tight oil sands of a character similar to those in its predecessor.

Richfield Cores Wheeler Ridge O.S.

Richfield Oil Corp.'s second deep try atop Wheeler Ridge at the southerly edge of the San Joaquin Valley is in good looking oil sand at 10,934 ft. The sand body is believed similar to, although it appears looser and richer than, the sands classified as San Emigdio in the first hole. Topped at 10,873 ft., the sands are not definitely identified and it is thought possible that they may be of Eocene age. Plans call for casing to be set at 10,865 ft. for tests of the horizon.

Union Extends Trico Gas Field

Completion of Union Oil Co.'s Seymour No. 1, in the exact center of the northwest quarter of sec. 20,24-23, has pushed the proved limits of the Trico gas field a quarter of a mile westerly.

Bottomed at 2461 ft. and with 85 ft. open below the shoe of 6⅝-in. casing at 2387 ft., the well initialed 10,285,000 cu. ft. through both tubing and casing. The tubing flow was unrestricted while the casing carried a ¾-in. bean and registered 525 lbs. pressure.

Herzog Starts Devils Den Try

Raymond D. Herzog has spudded Marine No. 28 in sec. 26,25-18 in the Devils Den area where he is attempting to duplicate other wells which have effected production of small amounts of good lube oil crude. A Texas syndicate is preparing to build a small processing plant to handle the lube stock produced in the area, though no starting date has been announced.

Shell Oil Innovates New Drilling Method

Pioneer of California slim hole drilling, Shell Oil Co. has again stepped ahead in the march of technical progress in slim hole technique. Using its Ten Section field once more as a proving ground, Shell is demonstrating the advantages of making one string do for both a drilling and a water string.

Specifically, the company used 4½-in. upset tubing for drilling and cemented the same string for water protection in a regular slim hole well, KCL No. A-36-29.

Use of the light pipe for drilling is held to present no hazard, a fact demonstrated by exhaustive wear tests on similar strings previously used for drilling only. Drilling to the normal 8300-ft. mark, average bottom in this field, is said to produce almost no surface wear and according to laboratory tests does not induce metal fatigue.

Texas Abandons Third Cantua Test

Drilled as Texas' third essay at commercial production along a structure previously drilled by other companies to unfruitful depths, Everding No. 1 was abandoned at 10,307 ft. in Eocene shale topped at 8831 ft. This well was drilled in sec. 24,17-15, a mile southeast of the company's second try in the area, S. P. No. 1, which flowed small amounts of gas, condensate and salt water from 9413 ft. after bottoming in shale at 10,116 ft. The sands from which the flow was made were found at 9345 ft. and are believed to be Eocene Gatchell sand equivalents. Rumors have it that the company will drill another well at a later date.

Montrose Visits Lane-Wells Division

M. E. Montrose, General Sales Manager of Lane-Wells Company, completed a six weeks' visit to the company's Mid-Continent and Gulf Coast Divisions prior to attending the A. P. I. in Chicago.

Mr. Montrose reports that the demands for Lane-Wells Gun Perforating, Electrolog and Survey Services for 1941 from all indications will be greater than the company's biggest year which is just closing. New field units are being completed as fast as possible to provide better service facilities in all areas served.

Great progress has been made in the new Lane-Wells Radioactivity Well Logging Service in the Mid-Continent. This service which permits logging through casing is being developed as rapidly as possible. Equipment is being constructed and field operators being trained. Extension of this service, which is available now only in certain Mid-Continent fields, will be made as soon as equipment can be completed.

Tank Service Division Moves Field Quarters

Due to the need of expanded quarters, Thos. W. Simmons, Tank Service Division, has moved its field headquarters to First and Prospect streets, Redondo Beach, Calif. Tank cleaning equipment is based at other strategic points for rapid dispatch to the scene of operations. Telephone service is maintained on a 24-hour basis at Redondo Beach 2209.

R. L. Tilton remains in charge of Mr. Simmons operations. The company's main offices are at 555 S. Flower St., Los Angeles, telephone VAndike 6134.

Coastal District

"Tex" Harvey Tests Gilmore Huasna Well

"Tex" Harvey Oil Corp. is following a policy of testing nearly every foot of the hole while drilling Gilmore Community No. 1 in Huasna Valley. Though no quantity of free oil has yet been recovered in the testing tool, each run has shown the presence of small quantities of gas and the mud has contained oil colors. Last reported drilling below 4150 ft., the project has not encountered the Vaqueros section of the Miocene.

Two miles southeast of the "Tex" Harvey well, Superior Oil Co. abandoned its Tar Springs Ranch No. 1 at 6500 ft. in Monterey Shale. Showings characteristic of the area were found in the brown shale fractures but were not tested.

Santa Barbara Wildcats Find Vaqueros Barren

Santa Barbara county's two wildcat tests were suspended last week when their objective, the Vaqueros, was found to be barren.

Deepest of the pair was Bolsa Chica Oil Corp.'s Permit No. 191-7 which stopped at 4313 ft. after finding a duplication of beds. The drill passed from the Miocent shale into gray Vaqueros sand, then into Sespe in logical sequence but after a short penetration of the latter formation, Vaqueros was again encountered. Drilling was continued until Sespe was re-entered.

There is said to be one more spot on the Coal Oil Point permit which remains to be explored but no announcement has been made of plans for new drilling.

Somewhat of a disappointment was Milburn & Hamilton's Rutherford No. 1 in the Refugio area west of the Capitan field. During the drilling it was evident that the structural position was higher than calculated, leading observers to believe production would be found in the Vaqueros sand. The horizon, topped at 1800 ft., was barren, however, and the operators are debating the advisability of drilling another well.

The Rutherford well was drilled with an efficient portable corehole rig at very low cost.

South Mountain Well Continues to Test

Heralded two months ago as the discoverer of an easterly extension of the South Mountain field, California Securities Oil Co.'s Schieferle No. 1 is now involved in one of those interminable series of plugs, tests and squeeze jobs which sometimes afflict a well like a dread disease.

Originally bottomed at 4500 ft., the hole was plugged to 4260 ft. and casing cemented at 2260 ft. On the first production test the well came in flowing and had all the earmarks of a good producer but mud and water soon broke in and since then there has been nothing but grief and lots of it. At present the well is being put on the pump with a good possibility that the persistence of the operators will be rewarded with modest production.

Believing that California Securities' trouble is of the mechanical sort that often dogs the steps of the pioneer in a new area, R. V. Rogers and Harry Rilling are planning to drill a new well under the name South Mountain Oil Co. The Comstock well, working only daylights, is down about 1700 ft.

New Well Finished In Santa Maria Valley

Brought in on the pump, Union Oil Co.'s Morrison No. 2 in sec. 27,10-34 produced at an initial rate of 150 bbls. per day. The well is located just south of hot spot area of three years ago. Production of the company's southeasterly extension project, Bradley Lands No. 2-1, has increased to better than 260 bbls. a day according to latest figures.

Union is now the only active operator in the Santa Maria Valley, having one well actually drilling, McCoy-Cooney 2-1 at 4500 ft., and derricks up for three more.

Texas Co. Starts New Oxnard Well

The long quiet Oxnard district will soon have two rotary tables turning as the Texas Co. is hauling equipment from its Kimberlin lease at Coalinga to the Montgomery property northeast of town. Preliminary grading work is already completed.

West of the city, E. A. Bender is drilling near the 4100 ft. level in Farrell No. 1.

Republic to Drill Gato Ridge Outpost

Republic Petroleum Co. is rigging up to drill a southwest flank outpost to the Gato Ridge field in sec. 16,8-32. Location of the test is the northeast corner of the Price property which adjoins leases of Barnsdall Oil Co. and The Petrol Corp.

In the proved portion of the field, The Petrol Corp. is deepening its Tognazzini No. 3-15 below 3300 ft.

Popular sound-dimmers for Londoners who worry about their ear drums during air raids are wads of cotton coated with a preparation of petroleum jelly.

COASTAL COUNTIES WILDCATS

Area	Well	No.	Section	Depth	Status
Santa Barbara County					
Elwood	Bolsa Chica Oil Co., Permit	191–7	24, 4-29	4313	Idle
Refugio	Milburn & Hamilton, Rutherford	1	36, 5-31	1858	Abandoned
Summerland	Barnato Corp., The, Hyland	1	16, 4-26	3415	Idle
San Luis Obispo County					
Huasna	Tex Harvey Oil Corp., Gilmore Comm.	1	11, 32-14	4150	Drilling
	Superior Oil Co., Tar Springs	1	24, 32-14	6500	Abandoned
Ventura County					
Bardsdale	Elkins, Reed	1	5, 3-19	902	Idle
	Hopland Oil Co.	1	1, 3-19		Rigging up
	Westoil Corp.	1	6, 3-19	525	Idle
Conejo	Sulphur Springs Oil Co., Janss	1	33, 2-19	4526	Idle
Ojai	Seaport Oil Corp., Arnett	3	15, 4-21	2361	Drilling
	Norwood Oil Co., Coronet	2	17, 4-21	3250	Drilling
	Norwood Oil Co., Coronet	3	17, 4-21		Grade
	Per-Col Oil Co., Anlauf	6	21, 4-21	2105	Swabbing
Oxnard	Bender, E. A., Farrell	1A	5, 1-22	2200	Drilling
	The Texas Co., Montgomery	1	13, 2-22		Location
Sespe	Inter Counties Fuel Co.	1A	22, 4-19	225	Drilling
	Riley, Irene Burson	1	18, 4-19	2050	Idle
	Rio Hondo Oil Co., Cosby	1	14, 4-19	1695	Idle
	Signal Petroleum Co.	7	13, 4-19	1263	Idle
South Mountain	Bolling Oil Co., Schieferle	1	17, 3-29		Grade
	Calif. Securities Oil Co., Schieferle	1	17, 3-29	4501	Rig pump
	Comstock Pet. Co.	1	17, 3-29	1600	Drilling
Sulphur Mt.	Madison Oil Co., Delphy	1	24, 2-22	2501	Stdg. cem.

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Oil Men's Calendar

Calif. Natural Gasoline Association. Los Angeles Chapter—Meets 1st Thursday Each Month, Barker Bros. Bldg., Los Angeles—Dinner at 6:00 (Optional). Taft Chapter—Meets Third Thursday Each Month.

American Society of Mechanical Engineers—Los Angeles Section—Meets 2nd Thursday Each Month—Barker Bros. Bldg., Los Angeles. Dinner at 6:30 (Optional).

December

2-6—American Institute of Chemical Engineers, New Orleans, La.
9-14 — National Asphalt Conference, Dallas, Texas.

1941

January

6-10—Society of Automotive Engineers, Annual Meeting (and Engineering Display), Book-Cadillac Hotel, Detroit, Mich.

Union Completing Cat Canyon Well

Union Oil Co. is completing its deep Cat Canyon well, Bell No. 11, with bottom at 5800 ft. and 7 in. casing with 485 ft. perforated landed and cemented through perforations at 5315 ft. Located in sec. 27,9-33, the well is virtually an offset to Standard Oil Co.'s Las Flores Land & Oil project which was whipstocked up up structure and brought in for 800 bbls.

Bryon Jackson Develops "Slim Hole" Drilling Tong

A Light Weight Rotary Tong, weighing only 136 pounds, has been designed by Byron Jackson Co. for use in "slim hole" drilling. This Tong is made for drill pipe up to 2⅞" diameter and has a patented double bore which permits it to grip upon either the drill pipe or tool joint. The jaws are equipped with a narrow die and are so designed that they have continuous contact around the pipe which will not be crushed even when breaking out tight joints. The T-head Spring Latch closes automatically and the tong grips instantly when applied on the pipe or tool joint.

The BJ "Light Weight" Rotary Tong embodies all of the features of convenience and safety found in larger tongs, including the BJ Rollover Lever whereby the tong can be reversed from "making-up" to "breaking-out" in 10 seconds' time

without lowering or disconnecting the tong. To reverse the action of the tong, merely unhook one suspension rod, roll the tong over, rehook the rod to the handle, and the tong is in working position completely reversed.

Made in 2⅜" and 2⅞" sizes only. By changing the Latch and Latch Lug Jaw, the 2⅜" tong is easily converted for use on 2⅞" pipe.

More complete information about the BJ "Light Weight" Rotary Tong may be secured from Byron Jackson Co., P. O. Box 2017, Terminal Annex, Los Angeles, California.

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